CANADIAN JOURNAL OF PSYCHOLOGY

VOL. 11, NO. 4, DEC., 1957

PUBLISHED FOR THE

CANADIAN PSYCHOLOGICAL ASSOCIATION BY THE

UNIVERSITY OF TORONTO PRESS

CANADIAN JOURNAL OF PSYCHOLOGY

VOLUME 11, NO. 4 DECEMBER, 1957

PUBLISHED FOR THE
CANADIAN PSYCHOLOGICAL ASSOCIATION BY THE
UNIVERSITY OF TORONTO PRESS

AUTHORIZED AS SECOND-CLASS MAIL, POST-OFFICE DEPARTMENT, OTTAWA

CANADIAN JOURNAL OF PSYCHOLOGY

Editor: J. D. KETCHUM *Assistant Editor*: H. O. STEER

THE CANADIAN JOURNAL OF PSYCHOLOGY is published quarterly in March, June, September, and December. ***Annual subscription***, **$4.00**; ***single number***, **$1.00**.

Subscriptions. Orders and correspondence regarding subscriptions, change of address, and purchase of back numbers should be sent to:

THE SECRETARY TREASURER, CANADIAN PSYCHOLOGICAL ASSOCIATION
Box 121, Postal Station K., Toronto, Ontario

Contributions. Original manuscripts and correspondence on editorial matters should be sent to:

THE EDITOR, CANADIAN JOURNAL OF PSYCHOLOGY
100 St. George Street, Toronto 5, Ont.

Information for contributors. The *Journal* publishes experimental and theoretical articles in all recognized fields of psychology. Contributors need not be members of the CPA or residents of Canada. Manuscripts should be double-spaced throughout, and should follow standard practice as regards tables, references, etc. "Immediate publication" (i.e. in the next issue to go to press) can be arranged for authors willing to pay the extra costs involved.

CANADIAN PSYCHOLOGICAL ASSOCIATION, 1957–1958

President: W. E. BLATZ, Toronto; *Past President*: JULIAN M. BLACKBURN, Kingston; *President Elect*: DALBIR BINDRA, Montreal; *Secretary Treasurer*: R. B. BROMILEY, Toronto. *Employment Bureau*: DR. H. DÖRKEN, 602 Jackson Bldg., Ottawa.

1958 Annual Meeting
Edmonton, Alberta
June 12, 13, 14

The Canadian Psychological Association also publishes *The Canadian Psychologist*, which is distributed to members only. *Editor*: C. M. MOONEY, Box 121, Postal Station K, Toronto

REACTIVE AND CONDITIONED INHIBITION IN PERCEPTUAL-MOTOR PERFORMANCE[1]

ROBERT TEGHTSOONIAN[2] AND A. H. SHEPHARD

University of Toronto

THIS STUDY is concerned with the predictive value of Hull's concepts of reactive inhibition (*Ir*) and conditioned inhibition (*sIr*) in the area of perceptual-motor learning.

Hull states that *Ir* is a negative drive state, generated whenever a response is evoked, tending to reduce the strength of that response. He further postulates that *Ir* dissipates spontaneously with time. Hence a higher level of performance is achieved by distributed practice, with interpolated rest intervals, than by massed (continuous) practice. In the latter the rate at which *Ir* is generated exceeds its rate of dissipation, and its cumulative effect is to depress the level of performance.

If a rest is introduced following a period of massed practice, a post-rest increment, called reminiscence, is generally observed in the level of performance; this, according to Hull, represents the dissipation of *Ir*. However, it has been observed that even after this recovery the level of performance is still below that achieved by distributed practice. This discrepancy is accounted for in Hullian theory by the second inhibitory factor, *sIr*, regarded as the association formed between the stimuli present at the cessation of practice and the resting response which necessarily follows cessation. This association is reinforced by the drive reduction inherent in the dissipation of *Ir* at the termination of massed practice. Since the stimuli most closely associated with the cessation of practice include those which elicit the practised response, their association with a resting response tends to lower the level of performance of the practised response. Thus both *sIr*, the habit not-to-respond, and *Ir*, the negative drive state, tend to depress performance. It should be noted that, since the strength of a habit is dependent upon the amount of reinforcement, the strength of *sIr* may be regarded as dependent upon the amount of *Ir* available for dissipation (drive reduction).

Although *sIr* has been referred to as a relatively permanent work decrement in contrast to the more temporary inhibitory effects of *Ir*, it is

[1]Based on a thesis submitted to the University of Toronto by Mr. Teghtsoonian in partial fulfilment of the requirements for the M.A. degree. The study was supported by the Defence Research Board of Canada under Research Grant 9401-02.

[2]Now at Princeton University.

reasonable to assume that, like other habits, it can be forgotten or unlearned. Hull does not deal specifically with the conditions under which the strength of *sIr* may be reduced, but it would be compatible with his theory to apply the principles of experimental extinction to *sIr*, as to any other habit. If the association of the resting response with certain stimuli were non-reinforced, the strength of that association should be reduced in proportion to the number of non-reinforced trials. Specifically, if a subject were required to make some *active* response to a stimulus to which a resting response had previously become associated, the probability of that stimulus evoking the resting response would be reduced. Regardless of the nature of the new active response, it would be antagonistic to a resting response. Such an interpretation would seem supported by the observation of Adams and Reynolds that the post-rest discrepancy between the performance level of a group originally given massed practice and one originally given distributed practice disappeared quickly when both groups resumed practice under conditions of distribution. (1).

Problem

In most contexts in which the constructs *Ir* and *sIr* have been used, *sIr* has been considered in terms of its effects on the *Ir*-generating response. There does not seem to have been any attempt to determine whether the resting response could become associated with stimuli other than those which evoked the *Ir*-generating response. As a result, the only method of measuring the effects of *sIr* has been to compare the post-rest performances of a massed-practice group and a distributed-practice group, both groups having equal amounts of practice. The observed post-rest discrepancy in favour of the distributed-practice group has been accepted as the measure of *sIr*.

The present study was designed to determine whether the resting response could become associated with a stimulus which was not related to the stimuli evoking the *Ir*-generating response. Although Hull, in speaking of the stimuli to which the resting response may become attached, refers simply to "stimuli . . . closely associated with the cessation of a given activity" (6, p. 75), his formulation seems to imply that the only stimuli concerned are those relevant to the practised response. His statement, however, does not preclude the possibility of the resting response becoming associated with a stimulus presented experimentally for the first time at the cessation of some activity. If reaction time (RT) to such a test stimulus had been previously measured, the degree to which a resting response had become associated with it could be measured by the discrepancy between the original RT and a second RT measure, taken

after the test stimulus had been presented under the conditions just described. It would be expected that a subject would react more slowly to a test stimulus to which a resting response had become associated.

If a delay is permitted between the cessation of some activity and the introduction of the test stimulus, the strength of the association of that stimulus with the resting response should be less than if there were no delay, since the delay would permit at least partial dissipation of *Ir* and the amount of *sIr* formed is dependent on the amount of *Ir* present.

The measuring of reaction time requires the subject to make an active response to some stimulus. It was suggested that the degree to which the resting response has become associated with a stimulus is to be measured by the change in RT to that stimulus. In the light of the earlier discussion of experimental extinction of the resting response, it would seem that the subject's responding in the RT measurement situation would tend to extinguish any resting response which had become associated with the stimulus being used. Thus, when the second series of RT measures is taken, the mean of the initial measures of the series should show a slowing down when compared with the original RT, indicating the effect of *sIr*. But a mean of the final measures of the series should indicate a return to the level of the original RT, reflecting extinction of the resting response.

If the preceding arguments are correct, three predictions can be made:

(1) A resting response will become associated with a stimulus presented at the cessation of some activity practised under massed conditions. The extent of this association can be measured by before-and-after measurement of reaction time to that stimulus.

(2) The process of measuring RT to a stimulus will tend to extinguish a resting response which has become associated with that stimulus. The extent of this extinction can be measured by comparing means of the earlier and later measures in the second series of RT measurements.

(3) The introduction of a delay between cessation of activity and presentation of the stimulus will lead to a weaker association between the stimulus and the resting response than if the stimulus were presented immediately at the cessation of activity.

Method

Subjects and Apparatus

Subjects were 40 male undergraduates at the University of Toronto, ranging in age from 20 to 41 years with a mean age of 24.4 years.

Equipment consisted of a reaction time apparatus, and a modified Two-Hand Coordinator (12), both constructed in the Department of Psychology, University of

Toronto. A 2,060 cycles per second tone at 70 decibels was presented to S from a Hewlett-Packard oscillator. Simultaneously a Standard Electric Timer was activated. By releasing a telegraph-type key S could stop both tone and timer, thus providing a measure of his RT to the tone.

The Two-Hand Coordinator was modified to a writing task in which S could control the movement of a pencil over a sheet of paper by rotating a control handle with each hand. The apparatus was located with controls and paper approximately 12 inches below the eye-level of the seated S.

Procedure

Each of the 40 Ss was randomly assigned to one of four groups. Each S's reaction time to the tone was measured 25 times, randomly interspacing the presentation of the tone with rest intervals of lengths varying approximately from 1.5 to 3.0 seconds.

Group 1 then operated the Two-Hand Coordinator for 7 3-minute periods separated by 60-second rest intervals. Each S was instructed to reproduce the same sentence, and to work steadily, writing as legibly as possible. Throughout the *first* 15 seconds of each rest period the tone used in the RT measures was presented. At the conclusion of this series of work and rest periods Ss were given a 5-minute rest. Reaction time to the tone was then measured again, using the same procedure as before.

Treatment of *Group 2* was identical with that of Group 1, except that the tone was *not* presented during the rest intervals between practice periods.

Treatment of *Group 3* was identical with that of Group 1, except that the tone was presented throughout the *last* 15 seconds of each rest interval.

For *Group 4* the tone was presented for 7 15-second periods separated by intervals of 225 seconds. Treatment of this group was identical with that of Group 1 except that Ss did not perform on the Two-Hand Coordinator.

In this design, the only purpose of the massed practice on the coordinator was to generate *Ir*. Groups 1 and 3, presented with the tone immediately after cessation of activity and after a 45-second delay respectively, were employed to test the hypotheses regarding association of the resting response with the tone. Group 4 served as control for the effects of sequential presentation of the tone, independent of performance on the coordinator. If results for this group indicate that repeated

TABLE I

SEQUENCE OF WRITING TASK, REST, AND PRESENTATION OF TONE FOR A FOUR-MINUTE PERIOD (SEQUENCE REPEATED SEVEN TIMES)

Groups	Time sequence in minutes			
(N = 10)	0.00–3.00	3.00–3.25	3.25–3.75	3.75–4.00
1	WT	T R	R	R
2	WT	R	R	R
3	WT	R	R	T R
4	R	T R	R	R

WT–Writing Task R–Rest T–Tone

presentation of the tone alone does not affect reaction time to that tone, it will be justifiable to employ Group 2 as a control for Group 1.

The experimental conditions for each group, shown in Table I, were repeated seven times. There were no rest intervals *between* these repetitions. According to Hull's principles (5, 6), the greater the number of repetitions the more pronounced should be the predicted association of the resting response with the tone. The number of repetitions was limited to seven by the time available.

Results

Measures

Table II shows the means of reaction times for the four groups. The column headed RT 1 presents group means of the last 20 of the 25 consecutive measures of the first set of RT measures. Since there was considerable variability in the ease with which subjects "adjusted" to the RT measurement situation, it was decided to omit the first five measures in determining the value of RT 1 for each subject. RT 1 was measured for all groups prior to any differential treatment between groups.

TABLE II

MEANS OF REACTION TIME
(IN HUNDREDTHS OF SECONDS)

Groups (N = 10)	RT 1	RT 2A	RT 2B
1	21.1	25.0	21.1
2	21.7	21.2	20.0
3	22.6	22.2	22.9
4	21.4	21.2	20.6

RT 1—Mean of the *last* 20 of the first set of 25 consecutive measures of reaction time.
RT 2A—Mean of the *first* 10 of the second set of 25 consecutive measures of reaction time.
RT 2B—Mean of the *last* 10 of the second set of 25 consecutive measures of reaction time.

Two measures of RT were derived from the second set of 25 measures: a mean of the first 10 measures and a mean of the last 10. These two measures are called RT 2A and RT 2B respectively. The difference between these two measures was used as an index of the extinction of the resting response. The difference between RT 2A and RT 1 was used as a measure of the development of the resting response. Both RT 2A and RT 2B were obtained following a 5-minute rest after the differential treatment between groups.

Table III shows the differences between the RT means for all groups

and compares them. The d1 column shows the differences between RT 1 and RT 2A; the d2 column the differences between RT 1 and RT 2B; and the d3 column the differences between RT 2A and RT 2B. The measure d1 was used as the measure of the association of the resting response with the tone, while d3, supplemented by d2, was used as the measure of the extinction of the resting response.

TABLE III

DIFFERENCES AND A COMPARISON OF THESE DIFFERENCES BETWEEN MEANS OF REACTION TIME (IN HUNDREDTHS OF SECONDS)

Group	d1 (RT 2A − RT 1)	d2 (RT 2B − RT 1)	d3 (RT 2A − RT 2B)	D1	D2	D3
1	3.9*	0	3.9*	—	—	—
2	−0.5†	−1.7*	1.2*	4.4*	1.7*	2.9
3	−0.4†	0.3	−0.7	4.3	−0.3	4.6
4	−0.2†	−0.8	0.6	4.1	0.8	3.3

Columns d1, d2 and d3 represent the differences shown in brackets below headings.
RT 1 —The mean of the last 20 of the first set of 25 consecutive RT measures.
RT 2A—The mean of the *first* 10 of the second set of 25 consecutive RT measures.
RT 2B—The mean of the *last* 10 of the second set of 25 consecutive RT measures.
D1 —The difference between d1 for Group 1 and d1 for each of the other groups.
D2 —The difference between d2 for Group 1 and d2 for each of the other groups.
D3 —The difference between d3 for Group 1 and d3 for each of the other groups.

*Significant at 5 per cent level of confidence.
†Tested, and found not significant.

In the D1 column, the differences between d1 for Group 1 and d1 for each of the other three groups are presented, while the D2 and D3 columns show corresponding differences for d2 and d3, respectively. The hypotheses regarding formation and extinction of the association of the resting response with the tone required comparison of the differences obtained for Group 1 with those obtained for Group 2. It was predicted that presentation of the tone immediately upon cessation of practice, rather than after a delay, would be a superior condition for associating the resting response with the tone. To test this hypothesis a comparison was made of the differences obtained in Group 1 with those obtained in Group 3. Thus the values D1, D2 and D3 were necessary to test all three hypotheses.

Effect of Repeated Presentation of Tone Alone on RT to Tone

In order to utilize Group 2 as a control for Group 1, it was necessary to determine whether repeated presentation of the tone alone had any

effect on RT to the tone. Since Group 4 was given identical treatment with Group 1 in respect to the presentation of the tone, but did not perform on the coordinator, a test of d1 for Group 4 would indicate whether reaction time had changed from RT 1 to RT 2A. This difference d1 was non-significant ($t = .40$, $df = 9$, $p > .60$). Thus any difference between Groups 1 and 2 could be attributed to the presentation of the tone in relation to work and rest periods on the coordinator rather than to the tone alone.

Effect of Tone Presented at Cessation of Practice on RT to Tone

It was predicted that presentation of the tone immediately at the cessation of practice on the coordinator would lead to association of the resting response with the tone. It was suggested that such an association could be measured by the slowing of RT to the tone following this treatment. This measure is d1, the difference between RT 2A and RT 1. Since the effect of practice on the coordinator on RT to the tone was not known in advance, it was necessary to compare d1 for Groups 1 and 2 by testing the difference D1 for Group 2. D1 was found to be significant ($t = 5.12$, $df = 18$, $p < .001$), d1 being greater for Group 1 than for Group 2.

Further tests showed that the difference d1 was significant for Group 1 ($t = 5.06$, $df = 9$, $p < .001$), but not for Group 2 ($t = 1.2$, $df = 9$, $p > .20$).

Extinction of the Resting Response

It was predicted that the active responding to a tone required for auditory RT measurement would tend to extinguish a resting response which had become associated with that tone. It was suggested that this extinction would be revealed by a speeding up in reaction time from RT 2A to RT 2B. This difference is represented by the difference d3 for Group 1. Since it was not previously known what improvement might take place from RT 2A to RT 2B when the tone was not employed in the differential treatment, it was necessary to compare d3 for Groups 1 and 2 by testing the difference D3 for Group 2. D3 was found to be significant ($t = 2.84$, $df = 18$, $p < .005$), the improvement in d3 being greater for Group 1 than for Group 2.

Further tests showed that d3 was significant for both Group 1 ($t = 4.59$, $df = 9$, $p < .001$), and Group 2 ($t = 2.86$, $df = 9$, $p < .01$).

To determine what over-all improvement in reaction time might take place regardless of the presentation of the tone, it was necessary to compare the difference d2 for Groups 1 and 2. This measure of the difference from RT 1 to RT 2B was greater for Group 2 than for Group 1:

that is, D2 for Group 2 was found to be significant ($t = 2.39$, $df = 18$, $p < .025$).

Further tests showed that d2 for Group 2 was significant ($t = 4.25$, $df = 9$, $p < .005$), indicating an improvement in reaction time from the first set of measures to the end of the second set, while d2 for Group 1 was zero, indicating that complete extinction of the resting response in Group 1 was not effected. This point will be discussed later.

Effect of Delay between Cessation of Practice and Presentation of Tone

It was predicted that a resting response would be more readily associated with a tone when that tone was repeatedly presented immediately at the cessation of practice, rather than after a delay. Since it has been suggested that d1, the difference between RT 2A and RT 1, be used as the measure of this association, the hypothesis may be tested by comparing d1 for Groups 1 and 3. The difference D1 for Group 3 was significant ($t = 4.94$, $df = 18$, $p < .001$), indicating that d1 was greater for Group 1 than for Group 3.

A further test showed that d1 for Group 3 was not significant ($t = 1.10$, $df = 9$, $p > .20$).

Discussion

Association of a Resting Response with a Tone presented at the Cessation of Practice, and following a Delay

The results support the hypothesis that a resting response will become associated with a tone which is repeatedly presented at the cessation of practice under massed conditions. It would seem that the drive properties of *Ir* are adequate, when *Ir* is dissipating, to bring about such an association. This is further confirmed by the finding that the association is more easily formed when the tone is presented immediately after the cessation of practice than it is after a delay. On the basis of Hull's theory, delay would make possible the dissipation of some or all of the accumulated *Ir* before the tone was presented, hence weakening the association.

The data do not permit direct generalization on the characteristics of the generation and dissipation of *Ir*; these characteristics were assumed as described by Hull and others (**5, 6, 7, 11**). The chief focus of interest was on the drive properties of *Ir*, and the extent to which they provide a basis for learning. The hypotheses tested were suggested by Hull's account of the formation of *sIr* as being dependent upon the dissipation of *Ir*. However, in Hull's theory and in nearly all research based on it the term *sIr* refers to the association of the resting response with the stimuli which evoked the *Ir*-generating response. The present study attempted to associate the resting response with a stimulus not related to the stimuli

evoking the *Ir*-generating response. For this reason the predicted association has not been called *sIr*. Hull's *sIr* suggested prediction of the association considered in this study. To the extent that our hypotheses were supported, the results may be regarded as providing indirect support for both Hull's inhibitory constructs, *Ir* and *sIr*.

The results give no definite information as to the specificity or generality of *Ir* as a negative drive. In those studies where *Ir* and *sIr* were considered only with respect to their effects on the *Ir*-generating response, it was often implicitly assumed that *Ir* was a specific drive not to make the response which generated it. However, a study such as the present one raises the question whether *Ir* is perhaps a general tendency not-to-respond to any stimuli.

In the study of Gustafson and Irion on bilateral transfer of *Ir* it was found that *Ir* generated by performance with one hand affected performance of the same task with the other hand (4). The authors concluded that *Ir* could not be considered a specific localized fatigue of the particular effector involved, but must be credited with some generality. In their study, however, though a different effector was used, the task remained the same; that is, the stimuli evoking the *Ir*-generating response were in principle the same for performance with either hand. Hence the question remains unanswered whether *Ir* is a tendency not-to-respond to any stimuli, or only to the stimuli which evoked the *Ir*-generating response.

Extinction of the Resting Response

The results supported the hypothesis that the active responding to the tone, required in the second series of RT measurements, would tend to extinguish a resting response which had become associated with that tone. It was noted, however, that over-all improvement in reaction time was greater for the control group (Group 2) than for the experimental group (Group 1), in which the tone was repeatedly presented at the cessation of practice. This suggests that there was perhaps some effect due to learning in the RT measurement situation. If the resting response developed in Group 1 had been completely extinguished, it would be expected that this group would finish at the same level of RT as the control group. Since this was not the case, it may be that only partial extinction of the resting response to the tone was effected in Group 1. It would then be expected that with further measures of RT to the tone Group 1 would reach the level obtained for the control group; the resting response to the tone would have been totally extinguished.

As noted earlier, Adams and Reynolds (1) observed that the post-rest discrepancy indicative of *sIr* disappeared when both groups resumed

practice under distributed conditions. Although their results seem amenable to the interpretation offered in this study, the authors conclude that their finding "does not necessarily constitute a clear-cut refutation of the *sIr* concept . . . [but] . . . does seem to present some difficulty for it" (1, p. 35). They seem doubtful about such a notion as experimental extinction of the resting response because "habit interference received little attention by Hull" (1, p. 35). The point at issue is not the adequacy of an entire theoretical system, but rather the utility of the *sIr* concept. Spence has pointed out that *sIr* is "like the interference or incompatible-response hypothesis" (16, p. 714), suggesting that a habit not-to-respond (*sIr*) is antagonistic to a habit to make an active response. It does not seem unreasonable, then, to suggest that the association of a resting response with certain stimuli will be weakened by the making of an active response to those stimuli. Since *sIr* is defined as a habit, there seems no reason why it should have a unique immunity to extinction.

Two implications of the present study may be pointed out. First, a tentative clarification of Hull's postulate on *sIr* is suggested: that the stimuli to which the resting response may become associated need not be limited to those which evoked the *Ir*-generating response, but may include all stimuli present at the onset of rest following massed practice. Secondly, a "tracer" technique is suggested for the investigation of inhibitory factors in motor learning. By presenting a novel stimulus at various stages during a rest following practice, the inhibition generated may be "sampled" and evaluated through measures of reaction time to the stimulus.

Summary

(1) The following hypotheses were tested: (*a*) The presentation of a tone at cessation of massed practice on a perceptual-motor task will lead to association of a tendency not to respond (a resting response) with the tone. (*b*) This association will be stronger than if a delay is permitted between cessation of practice and presentation of the tone. (*c*) It will tend to be weakened by the active responding to the tone required in a measurement of reaction time to the tone.

(2) Four groups of subjects were employed, whose reaction time to a tone was measured both before and after the differential treatment. Three groups practised for 7 3-minute periods separated by 60-second rest intervals on a modified Two-Hand Coordinator. For Group 1 the tone was presented for the first 15 seconds of each rest period. For Group 2 the tone was not used at all in relation to practice on the coordinator. For Group 3 the tone was presented throughout the last 15 seconds of each

rest period. Group 4 was treated like Group 1, but did not perform at all on the coordinator.

The hypotheses were tested by comparisons among the groups of differences in reaction time to the tone, measured before and after the differential treatment.

(3) All three hypotheses were supported by the data. It was concluded that the results provide indirect support for Hull's concepts of reactive and conditioned inhibition, but that the latter concept might be broadened to state that a resting response can become associated with *any* stimuli present at the cessation of massed practice.

REFERENCES

1. Adams, J. A., & Reynolds, B. Effect of shift in distribution of practice conditions following interpolated rest. *J. exp. Psychol.*, 1954, **47**, 32–36.
2. Ammons, R. B. Acquisition of motor skill: II. Rotary pursuit performance with continuous practice before and after a single rest. *J. exp. Psychol.*, 1947, **37**, 393–411.
3. Archer, E. J. Postrest performance in motor learning as a function of present degree of distribution of practice. *J. exp. Psychol.*, 1954, **47**, 47–51.
4. Gustafson, L. M., & Irion, A. L. "Reminiscence" in bilateral transfer. *J. exp. Psychol.*, 1952, **43**, 321–323.
5. Hull, C. L. *Principles of behavior.* New York: Appleton-Century, 1943.
6. Hull, C. L. *Essentials of behavior.* New Haven: Yale Univer. Press, 1951.
7. Kimble, G. A. An experimental test of a two-factor theory of inhibition. *J. exp. Psychol.*, 1949, **39**, 15–23.
8. Kimble, G. A. Performance and reminiscence in motor learning as a function of the degree of distribution of practice. *J. exp. Psychol.*, 1949, **39**, 500–510.
9. Kimble, G. A. Evidence for the role of motivation in determining the amount of reminiscence in pursuit rotor learning. *J. exp. Psychol.*, 1950, **40**, 248–253.
10. Kimble, G. A. Transfer of work inhibition in motor learning. *J. exp. Psychol.*, 1952, **43**, 391–392.
11. Kimble, G. A., & Shatel, R. B. The relationship between two kinds of inhibition and the amount of practice. *J. exp. Psychol.*, 1952, **44**, 355–359.
12. McFarland, R. A., & Channel, R. C. A revised serial reaction time apparatus for use in appraising flying aptitude. Washington, D.C.: Report no. 34, C.A.A. Airman Development Division, September, 1944.
13. Reynolds, B., & Bilodeau, I. McD. Acquisition and retention of three psychomotor tests as a function of distribution of practice during acquisition. *J. exp. Psychol.*, 1952, **44**, 19–26.
14. Rockway, M. B. Bilateral reminiscence in pursuit-rotor learning as a function of first-hand practice and length of rest. *J. exp. Psychol.*, 1953, **46**, 337–344.
15. Schucker, R. E., Stevens, L. B., & Ellis, D. S. A retest for conditioned inhibition in the alphabet-printing task. *J. exp. Psychol.*, 1953, **46**, 92–102.
16. Spence, K. W. Theoretical interpretations of learning. In S. S. Stevens (Ed.) *Handbook of Experimental Psychology.* New York: Wiley, 1951.

THE TAYLOR SCALE, HUNGER, AND VERBAL LEARNING[1]

LEON J. KAMIN[2] AND OLGA FEDORCHAK[3]

Queen's University

THE NUMBER OF STUDIES relating score on Taylor's Manifest Anxiety Scale to various experimental performances is now very large (12). Although the theoretical significance of such empirical findings is not entirely clear, the recent statement by Spence, Farber, and McFann (10) does clarify the position of the Iowa group. These workers regard Taylor score as an index of a subject's "emotional responsiveness," or drive. That is, *S*'s scale score is taken as one estimate of the magnitude of Hull's *D* (5) operative within *S*. Thus the differences to be expected between the performances of high and low scale scorers are those theoretically associated with variation of *D*.

Presuming the Iowa group's interpretation of performance differences between high and low Taylor scorers to be correct, it is obvious that similar differences should be observed if *D* is experimentally manipulated independently of Taylor score. Thus, for example, if two groups of human subjects differ widely in hunger drive, one would expect their experimental performances to differ in the same way as do the performances of high and low Taylor scorers. Without some such supporting evidence, the Iowa interpretation of Taylor Scale data in terms of irrelevant *D* is seriously clouded by the confounding of Taylor score with various personality and intellectual measures[4] (3, 6).

Our study was undertaken first to repeat findings by the Iowa group (9, 10) that high Taylor scorers learn paired-associates more rapidly than do low scorers when intra-list response competition is minimal. The division of our *Ss* into high and low Taylor score groups was cross-cut, however, with half the *Ss* in each group being tested when they had been deprived of food for one day and half being tested shortly after a normal

[1]Based in part on an undergraduate honours thesis submitted by O.F. to the Psychology Department, Queen's University, where the study was carried out. The work was supported in part by a grant from the McLaughlin Science Fund of Queen's University.

[2]Now at McMaster University, Hamilton.

[3]Now at the University of Toronto.

[4]A very recent report indicates that hunger and high Taylor score do not have similar effects on acquisition of the conditioned eyeblink. See C. M. Franks, Effect of food, drink, and tobacco deprivation on the conditioning of the eyeblink response (*J. exp. Psychol.*, 1957, **53**, 117–120).

meal. We were concerned chiefly with the effects of the anxiety and hunger variables on learning. We believed that, should hunger exhibit an effect similar to the effect of Taylor score, the case for Taylor score as a measure of irrelevant *D* would be very greatly strengthened. Conversely, a dissimilar effect would weaken it.

We must note, however, that the drive or energizing characteristics of hunger in humans have been little studied. There is a very early study by Wada (13) which reported, in a few *Ss*, increased strength of grip during hunger pangs. Wada also claimed that hunger had a beneficial effect on scores on intelligence tests. To measure hunger we have adopted from animal studies the use of hours of food deprivation as an index. We believe it reasonable to assume that our groups differed significantly in hunger drive, but we have no detailed knowledge of the shape of the function relating *D* to hours of food deprivation in man. The verbal reports of our deprived *Ss* support the view that they were in a strong drive state.

Method

Subjects

The *Ss* were 40 students in an introductory psychology class, selected on the basis of scoring within either the upper or lower 20 percentiles of the Taylor Scale, which had been administered to the entire class. There were, within each Taylor score group, 10 males and 10 females. Within each of these 4 sub-groups half the *Ss* were hungry and half sated. There were thus 8 independent groups in a $2 \times 2 \times 2$ factorial design, with 5 *Ss* per group. The design allows an assessment of the effects of hunger, Taylor score, and sex, plus their interactions. The *Ss* were experimentally naïve, none having served in any earlier study.

Apparatus

Paired-associate learning materials were presented on a Gerbrands memory drum. The successive stimulus items of a list were exposed every 3 seconds, with an anticipation interval of approximately 1.2 seconds. There was a 3-second rest interval between successive presentations of a list. The *S* was first exposed to a practice list (15 paired nouns) to acquaint him with procedure. The test list was that employed and published by Spence, Farber, and McFann (10). The 15 paired adjectives of the test list had been so selected as to maximize strength of association between paired stimulus-response terms, while meaningful intra-list associations and formal similarities were minimized. The test list thus minimizes response competition. The list consists of such paired terms as adept-skilful, barren-fruitless, complete-thorough, etc. The derivation drawn from Hullian theory by Spence *et al.* maintains that high *D* should facilitate learning of such a non-competitional list. The lists were presented to *S* in 3 different orders to prevent serial learning.

Procedure

There was no difference in the treatment of experimental groups other than, of course, the control of hunger. Of the *Ss* 20 were tested within 2 hours after completion of a normal meal, and 20 were tested 21 to 24 hours after their last food

(supper). The hungry Ss had eaten no solid foods during their fast but had been allowed to sip small amounts of liquids. Each S, after preliminary instructions describing procedure, was given 6 trials on the practice list followed by a 2-minute rest. He then learned the test list to a criterion of 2 successive perfect trials. It had been arranged that any S failing to make one or making more than 50 correct responses on the practice list would be discarded, but no discards were necessary.

The above procedure, it should be noted, is *not* an exact replication of that employed by Spence *et al.* The Iowa workers employed a 4-second interval between successive stimulus items of a list, with a 1.67-second anticipation interval. The corresponding intervals in our study were 3 and 1.2-seconds.

Results

Performance was scored in terms of both number of trials required to achieve the learning criterion and total number of errors made during learning. The raw counts exhibited both heterogeneity of variance and a tendency for variances to be proportional to means. These conditions were corrected by a logarithmic transformation of all scores before analyses of variance.

TABLE I

Mean Number of Trials to Criterion and of Errors by Experimental Groups

	Hungry		Sated	
	Trials	Errors	Trials	Errors
High anxious males	35.4	177.2	30.0	147.4
Low anxious males	20.8	84.0	18.2	83.6
High anxious females	14.4	70.4	21.4	85.8
Low anxious females	17.8	78.4	15.2	55.6

Table I presents mean raw scores for all groups for both trial and error measures. Table II summarizes analyses of variance of both trial and error scores, transformed. It will be seen that hunger had no effect whatever. The *F* for the hunger variable is in each case less than one. However, anxiety did have an effect which is significant for error scores and approaches significance for trial scores. The effect of anxiety in the present study is, however, in a direction *opposite* to the significant effects twice reported by Spence *et al.* That is, in our data high Taylor score is associated with poorer learning. The effect of sex, finally, is also significant, with females learning both more rapidly and with fewer errors than males. The various interactions in Table II are not significant.

There were no significant effects revealed by an analysis of variance

TABLE II

SUMMARY OF ANALYSIS OF VARIANCE OF TRANSFORMED TRIAL AND ERROR SCORES

Source		Trials			Errors		
	df	Mean square	*F*	*p*	Mean square	*F*	*p*
Hunger	1	5.63	—	—	46.21	—	—
Anxiety	1	1729.23	3.23	<.10	3115.22	4.38	<.05
Sex	1	2576.03	4.81	<.05	3591.03	5.05	<.05
Anxiety×sex	1	783.23	1.46	>.20	801.03	1.13	>.20
Anxiety×hunger	1	714.03	1.33	>.20	342.23	—	—
Sex×hunger	1	342.23	—	—	18.23	—	—
Triple interaction	1	442.19	—	—	390.65	—	—
Error	32	535.76			711.51		

of practice list performance. The practice list was not consciously constructed to minimize intra-list interference and thus presumably involved more competition than did the test list. The non-significant differences on the practice list nevertheless paralleled in direction those obtained with the test list.

DISCUSSION

The Hunger Variable

The two levels of hunger employed in this study clearly had no differential effect on performance. These data suggest that irrelevant *D* does not affect the performance of human *Ss* in rote verbal learning.[5] Although the failure of hunger and anxiety to have similar effects casts doubt on interpretations of Taylor score effects as attributable to *irrelevant D*, it must be noted that this failure has little bearing on interpretations of Taylor score effects as attributable to *relevant D*. The Taylor Scale was constructed to measure a particular kind of *D*—manifest anxiety—and the experimental situations in which Taylor score has been demonstrated to have an effect may each be regarded as involving anxiety. The Iowa workers have themselves vacillated between regarding Taylor score as an index of *S*'s chronic *D* level and regarding it as an index of his *D* level in anxiety-eliciting situations only (**4, 11, 14**). The first of these notions involves interpreting Taylor score effects in terms of irrelevant *D*, but the second is compatible with interpretations in

[5]Possibly, it can be argued, control of hours of food deprivation does not constitute variation of *D* in human subjects. The antecedent conditions for establishment of *D* are not very explicitly stated by Hull, but his own consistent use of hours of deprivation (with rats) makes this index seem appropriate.

terms of relevant *D*. Thus it is conceivable that Taylor score does predict *D* level in situations where *S* is threatened, physically or by pressure for "good" performance; at the same time it is wholly conceivable that a strictly irrelevant *D* (hunger) has no significant effect on human verbal learning.

Effect of Anxiety

The effect of Taylor score in this study runs strikingly counter to the results of the Iowa workers; interpretation of performance differences between high and low scale scorers is clearly no simple matter. We can, however, offer two alternative rationalizations of the conflicting data. The first, and simplest, hinges on the Iowa group's concept of response competition. The derivation drawn from Hull by the Iowa workers asserts that an interaction should exist between Taylor score and degree of response competition. That is, high Taylor scorers should excel only in "non-competitional" tasks such as the learning of the present list. However, as Saltz and Hoehn (8) have indicated, the Iowa group tends to equate response competition with *difficulty*. Although our and the Iowa studies involve an equal degree of response competition as defined by the common test list, our use of briefer anticipation intervals made learning the task more *difficult* for our Ss. This is indicated by the mean number of trials required to achieve criterion: 21.4 for our Ss, 10.3 for Iowa Ss. Thus, a theory which predicts a marked interaction between motivational level (Taylor score) and task difficulty could subsume the discrepant data. This is not, however, the Iowa theory; and independent definition of the dimension of task difficulty is a knotty problem.

The alternative interpretation assumes that Taylor score is an index of relevant *D*, but that the function relating *D* to performance is U-shaped. Then, with the further assumption that the "baseline motivational level" induced in our Ss is higher than that induced in Iowa Ss, the reversal of results can be rationalized. Presume that a given set of experimental conditions establishes some baseline motivational level, and that moderate motivation facilitates but *over*-motivation impedes performance. Then the effects of the increment to baseline motivation presumably associated with high Taylor score must depend upon the location on the U-function of the baseline motivational level. This *post hoc* argument is obviously circular without independent study and controlled variation of factors which might determine "baseline motivational level" —instructions, experimenter's behaviour, etc. We advance it because naïve observation of our high Taylor scorers suggested, very simply, that they were "trying too hard."

We believe that, taken as a whole, the complex patterns of empirical

relations between Taylor score and experimental performances do not allow any simple interpretation. What remains clear is that high and low scale scorers are people who differ in some fundamental way.

Effect of Sex

We did not expect the significant effect of sex which was revealed. Whether the Iowa group has observed a similar effect in verbal learning is not clear. Though Spence, Farber, and McFann (10) assign equal numbers of each sex to each anxiety group, they do not provide a complete summary of their analysis of variance. They report a significant F for anxiety and an anxiety $\times$ sex interaction less than one, but there is no reference to the F for the sex variable. The study of Spence, Farber, and Ketchel reports the use of "appropriate controls for sex and E" (9, p. 308), but no reference is made to possible main effects or interactions involving these variables. Possible effects are of some relevance since many earlier studies employing the Taylor scale did not control for these variables; in at least one study of verbal learning (7) a statistically significant disproportion of women appears in the high anxiety group.

We have no obvious interpretation of the effect of sex in our data. There was no apparent difference, from records available to us, in the intellectual capacities of male and female Ss. Although women tend to surpass men in verbal facility (1), we can find no reference to sex differences in rote verbal learning. The findings of Axelrod, Cowen, and Heilizer are of interest in this regard (2). They failed to find a significant effect of Taylor score on human maze-learning, but did report significant interactions involving $E \times$ sex, anxiety $\times$ sex, and anxiety $\times E$! We suspect that the fact that the single experimenter in our study was a female may not be irrelevant. Whatever the interpretation of these complex effects, it seems prudent to control sex and E variables in Taylor Scale studies; and it is not unlikely that intensive study of these effects might clarify interpretation of the Taylor score.

Summary

The variables of manifest anxiety, hunger, and sex were dichotomized in a $2 \times 2 \times 2$ factorial design according to which 40 Ss learned a noncompetitional list of paired-associate adjectives. There were significant main effects of manifest anxiety and of sex, with high anxiety and male sex associated with poor learning. There was no effect of hunger, and no interaction was significant.

The failure of manifest anxiety and hunger to have similar effects suggested that the effect of Taylor Scale score cannot be interpreted in

terms of irrelevant *D*. The reversal in direction of the effect of manifest anxiety from that reported at Iowa suggested a number of theoretical speculations concerning the relation between Taylor Scale score and experimental performance.

REFERENCES

1. Anastasi, Anne, & Foley, J. P. *Differential psychology.* New York: Macmillan, 1949.
2. Axelrod, H. S., Cowen, E. L., & Heilizer, F. H. The correlates of manifest anxiety in stylus maze learning. *J. exp. Psychol.*, 1956, **51**, 131–138.
3. Eriksen, C. W. Some personality correlates of stimulus generalization under stress. *J. abnorm. soc. Psychol.*, 1954, **49**, 561–565.
4. Farber, I. E., & Spence, K. W. Relation of stimulus intensity, practice, anxiety, and sex to simple RT and temporal generalization. Iowa City: State Univer. of Iowa, June 27, 1955 (*ONR Contract* N9 onr-93802, *Tech. Rep.* no. 4).
5. Hull, C. L. *Principles of behavior.* New York: Appleton-Century, 1943.
6. Kerrick, Jean S. Some correlates of the Taylor Manifest Anxiety Scale. *J. abnorm. soc. Psychol.*, 1955, **50**, 75–77.
7. Montague, E. K. The role of anxiety in serial rote learning. *J. exp. Psychol.*, 1953, **45**, 91–96.
8. Saltz, E., & Hoehn, A. J. A test of the Taylor-Spence theory of anxiety. *J. abnorm. soc. Psychol.*, 1957, **54**, 114–117.
9. Spence, K. W., Farber, I. E., & Ketchel, Rhoda. Anxiety (Drive) level and degree of competition in paired-associates learning. *J. exp. Psychol.*, 1956, **52**, 306–310.
10. Spence, K. W., Farber, I. E., & McFann, H. H. The relation of anxiety (drive) level to performance in competitional and noncompetitional paired-associates learning. *J. exp. Psychol.*, 1956, **52**, 296–305.
11. Spence, K. W., Farber, I. E., & Taylor, Elaine. The relation of electric shock and anxiety to level of performance in eyelid conditioning. *J. exp. Psychol.*, 1954, **48**, 404–408.
12. Taylor, Janet A. Drive theory and manifest anxiety. *Psychol. Bull.*, 1956, **53**, 303–320.
13. Wada, T. An experimental study of hunger in its relation to activity. *Arch. Psychol.*, 1922, **8**, no. 57.
14. Wenar, C. Reaction time as a function of manifest anxiety and stimulus intensity. *J. abnorm. soc. Psychol.*, 1954, **49**, 335–340.

AGE IN THE DEVELOPMENT OF CLOSURE ABILITY IN CHILDREN

CRAIG M. MOONEY[1]

Defence Research Medical Laboratories
Toronto, Ontario

CLOSURE is the perception of an object or event which is not completely or immediately represented. Previous studies (**1, 2, 3, 4, 5, 6, 7, 8, 9**) have revealed marked individual differences in this perceptual ability, but have thrown little light on its development.

Street's use of a *Gestalt Completion Test* with school children revealed no consistent or significant differences in scores attributable to age—which later prompted Thurstone (**7**, p. 9) to remark that the finding was of interest "as an indication that the test involves some factors which mature at an early age, and it may be taken as indicative of some fundamental and primitive function." The study by Verville and Cameron (**9**) of age and sex differences in the perception of incomplete pictures by adults revealed slight differences in reaction times and perceptual set attributable to age, but did not reveal a relationship between age and perceptual ability. Street's test comprised only thirteen items in its final form; the items were not of a single class; nor could the particular percepts be presumed to be universally familiar. Verville and Cameron used only ten items, and they were checking age differences between two groups of adults—those aged 16 to 23 and those aged 35 to 56. Both studies are open to the presumption that the tests, subjects, and procedures were not adequate to reveal an association between perceptual ability and age.

The present study was undertaken to reveal, through an early age range, the likely association between closure ability and age. The procedure was designed to minimize the differential effects of prior perceptual experience through the use, on the one hand, of subjects of common social and educational background, and, on the other hand, of closure test-items representative of a single class of percepts that might be presumed to be universally familiar. In short, the aim was to correlate closure ability and age in a uni-dimensional perceptual domain.

METHOD

Subjects

Subjects were 245 school children (119 girls, 126 boys) aged 7 to 13 in these grades: II (28), II (32), III (28), IV (33), V (33), VI (31), VII (28), and VIII

[1]The author wishes to acknowledge the valuable assistance of Mr. W. C. Clegg in the preparation of test materials, the testing programme, and the analysis of data.

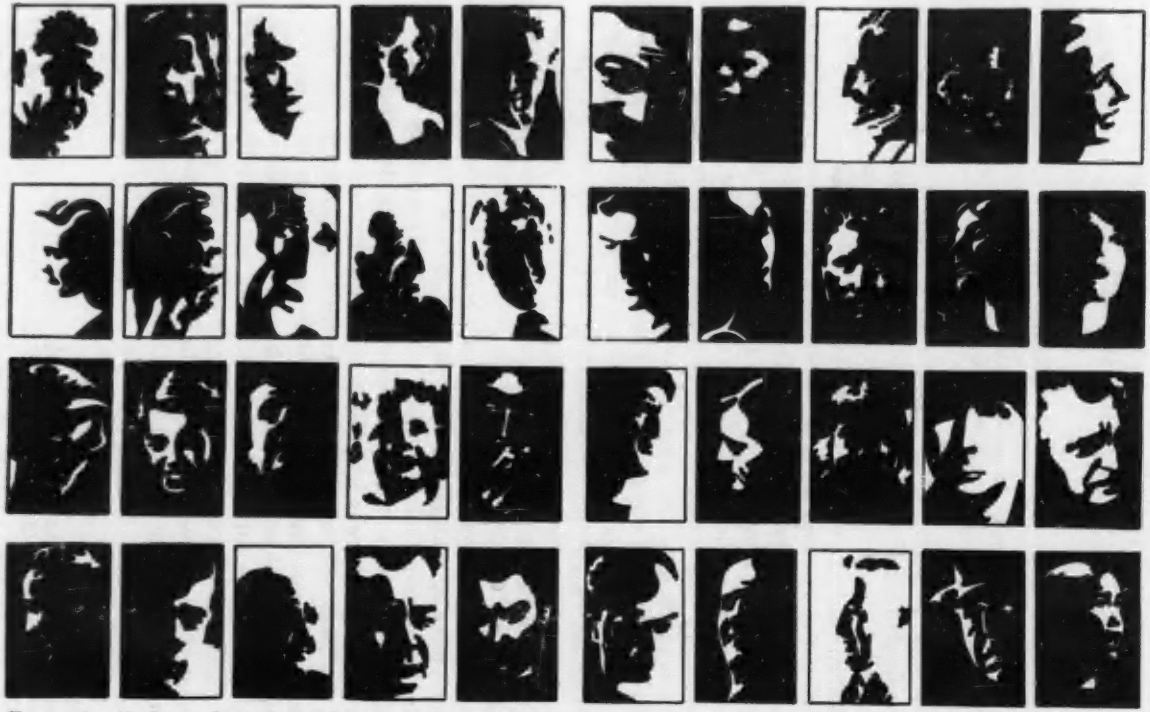

FIGURE 1. 40 closure faces arranged with the most difficult 5 at upper left, next most difficult 5 at upper right, and so on down to easiest 5 at lower right.

(32). Grades II to VI were in the same preparatory school; grades VII and VIII were in a junior high-school of the same community. In addition, 30 adult soldiers selected at random were included for purposes of incidental comparison.

Materials

The closure items were drawings of the heads and faces of miscellaneous people. They presented, in solid blacks and whites, only the salient shadows or high-lights, as revealed in strongly lighted photographs. Such incomplete pictures called for closure. When perceived they convincingly resembled their originals. Additional false items (similar in terms of graphic stuff but otherwise nonsensical) were used. The 50 real and 20 false items were printed on 3" × 4" cards, assembled in decks, shuffled, and boxed.

Procedure

Subjects were group-tested by grades by the same experimenter in their own class-rooms. They were required to sort their decks of cards, according to a prescribed system, into 7 categories: BOY, GROWN-UP MAN, OLD MAN, GIRL, GROWN-UP WOMAN, OLD WOMAN, and—for those they could not identify—LEFT OVER. Thirty minutes were allowed.

One of the grades II and grades IV and VI were retested after an interval of two weeks.

Scoring entailed a count of correct answers. These were prescribed beforehand. For example, where degree of age was debatable but sex was not, the acceptable answer for a particular male item would be GROWN-UP MAN or OLD MAN; or, if age was clear but sex not, OLD MAN or OLD WOMAN; or, if sex and age were evident, simply BOY. Answers to 10 of the real items were randomly scattered and these were discarded. Subsequent analysis was based on answers to the remaining 40 real and 20 false items. The 40 real items are presented in Figure 1.

Items were ranked and then grouped in fives for difficulty, as shown in Figure 1, on the basis of correct answers for the total N (245). Thereafter two kinds of comparisons were made. The first revealed the percentage accomplishment of the successive school grades and the adult Ss with successively less difficult groups of items. The second revealed the percentage accomplishment of successively more proficient groups of Ss with these groups of items. The aim was to ascertain if the difficulty order of the items remained constant for gradations of ability and age, and to reveal the relationship between the latter two factors.

RESULTS

The reliability of the testing procedure is indicated by the test-retest product-moment correlation coefficient of .72 (with 87 Ss from grades II, IV, and VI).

Table I provides a general picture of the perceptual performance. There is a marked improvement in performance between grades II and VIII. Notable also is the markedly greater reluctance on the part of older children to dismiss items as "not seen" and, in consequence, their tendency to categorize the false items erroneously. That this tendency is not an exclusive function of age is indicated in Table II. Here, using only the

TABLE I

PERFORMANCE OF SCHOOL CHILDREN AND ADULTS WITH 40 REAL AND 20 FALSE CLOSURE FACES

School grades	N	Percentage correctly categorized		Percentage erroneously categorized		Percentage categorized not seen	
		Real	False	Real	False	Real	False
II	32	36	—	28	54	36	46
II	28	39	—	32	57	29	43
III	28	48	—	26	64	26	36
IV	33	52	—	25	61	23	39
V	33	51	—	26	62	23	38
VI	31	62	—	29	84	9	16
VII	28	64	—	28	85	8	15
VIII	32	72	—	23	84	5	16
Adults	30	68	—	15	63	17	37

grade II children and adults as extreme but representative examples, Ss have been grouped from lowest scoring sixth to highest on performance with the real items; and it is evident that the more proficient Ss less frequently dismiss the false items as unrecognizable.

Table III summarizes a check made for possible sex differences. Twenty items were so chosen that ten represented male and ten female faces; these were rigorously scored—that is, only one of the six answer categories was accepted as correct. There are no significant differences between boys and girls in total performance or in their handling of items in terms of sex.

TABLE II

PERCEPTUAL COMMITMENT WITH 20 FALSE CLOSURE FACES IN TERMS OF ACCOMPLISHMENT ON 40 REAL BY SEVEN-YEAR-OLD CHILDREN AND ADULTS

		Ss grouped by sixths for accomplishment with real items					
		1st	2nd	3rd	4th	5th	6th
Grades II				(percentages)			
($N = 60$)	Real seen	13	23	31	38	51	68
	False "seen"	24	39	60	44	71	92
Adults							
($N = 30$)	Real seen	38	53	69	74	83	93
	False "seen"	31	54	59	60	78	90

TABLE III

PERCENTAGE ACCOMPLISHMENT OF BOYS AND GIRLS WITH 10 MALE AND 10 FEMALE CLOSURE FACES

Closure faces	Grade II		Grades III, IV, V		Grades VI, VII, VIII		Total	
	Girls (27)	Boys (33)	Girls (47)	Boys (47)	Girls (45)	Boys (46)	Girls (119)	Boys (126)
10 Male	27	22	38	39	50	46	40	37
10 Female	26	15	36	33	54	49	41	34
Male and female	27	19	37	36	52	48	40	36

TABLE IV

DISTRIBUTION OF SCORES ON CLOSURE FACES TEST BY GRADE SCHOOL CHILDREN AND ADULTS

Score intervals		Grades							Adults
		II	III	IV	V	VI	VII	VIII	
39	40								
37	38				0	1	0	2	4
35	36				1	0	1	3	1
33	34	1	1	1	1	2	0	3	4
31	32	0	1	1	0	5	2	5	1
29	30	1	1	1	2	1	4	4	6
27	28	3	4	5	1	5	4	7	3
25	26	5	3	3	4	1	4	0	1
23	24	2	2	5	5	3	7	4	1
21	22	4	3	4	3	7	3	2	2
19	20	1	1	0	3	2	1	0	1
17	18	2	2	4	5	1	1	0	3
15	16	9	1	2	2	2	1	1	1
13	14	5	2	3	2	0	0	1	1
11	12	8	1	2	1	1	0	0	1
9	10	7	0	0	2				
7	8	7	3	2	0				
5	6	1	2	0	0				
3	4	2	1	0	0				
1	2	2	0	0	1				
N		60	28	33	33	31	28	32	30

TABLE V

PERCENTAGE ACCOMPLISHMENT ON CLOSURE FACES TEST BY DIFFERENT AGE GROUPS WITH SUCCESSIVELY EASIER GROUPS OF ITEMS

Item groups	Grades			Adults	All
	II	III, IV, V	VI,VII,VIII		
1	16	25	41	37	30
2	22	35	57	52	41
3	29	37	59	60	45
4	35	48	62	77	53
5	37	58	72	67	59
6	45	64	74	75	64
7	51	65	79	87	69
8	62	74	84	90	76
All	37	51	66	68	55

The distribution of results by grades is given in Table IV. The correlation coefficient is .546 and the correlation ratio is .585. The latter is a significantly better (beyond .01 level) measure of the degree of association, since the regression deviates slightly but significantly (.01 level) from linearity. Since the data are subsequently presented in ratio form, they become essentially linear when appropriately transformed to a normal probability scale.

The main findings are most simply presented in Tables V and VI. The forty items have been grouped from the five most difficult to the five

TABLE VI

PERCENTAGE ACCOMPLISHMENT ON CLOSURE FACES TEST BY DIFFERENT SCORING GROUPS WITH SUCCESSIVELY EASIER GROUPS OF ITEMS

Item groups	Score intervals					All
	1–8	9–16	17–24	25–32	33–40	
1	5	9	23	42	71	30
2	9	15	36	59	82	41
3	8	24	38	61	88	45
4	12	30	53	67	84	53
5	18	35	61	74	91	59
6	20	40	64	82	93	64
7	14	46	69	89	96	69
8	30	61	79	89	95	76
All	15	32	53	70	87	55

easiest. Subjects have been grouped by grades in Table V, and by levels of accomplishment in Table VI. Table V shows the percentage accomplishment of different age groups at the different levels of item difficulty. Table VI shows the percentage accomplishment of Ss of different levels of ability at the different levels of item difficulty. Absolute differences between these S groups, and the constant relative increases between S groups at different levels of item difficulty, are significant (.01 level), as checked by analysis of variance and goodness of fit tests.

Discussion

The perceptual competence entailed in this kind of closure exercise is positively and significantly associated with age. That it is not exclusively associated with age is evident from the fact that the ranges of subject differences and of item difficulties remain as marked at later ages as at early ones.

The constant order of difficulty of the items, for all age or ability levels, suggests that the forty items define a single perceptual domain, and that they differ in some quality determinative of the class of percepts called for.

The constant increases in competence—along either the age or ability dimensions—at successive levels of item difficulty, along with the consistent over-all increases with successive increments of age, suggest the probable basis of the age-ability association—namely, that all Ss have an identical, uniformly repeated, year-by-year experience with this perceptual domain.

There then remain two distinct parameters which are basically independent of age. These are differences among Ss in inherent ability, and differences among test-items in inherent difficulty.

Summary

This study was designed to reveal the relationship between age and ability in perceptual closure. It laid down as critical requirements the testing of a large number of children differing in age but of similar social and educational background with an ample number of a single class of percepts that could be presumed to be universally familiar.

A test composed of 40 incomplete black and white representations of the heads and faces of particular kinds of persons was given to 245 children in grades II to VIII in a single community, and to 30 adults.

The analysis of scores in terms of correct perceptions revealed a constant range of item difficulty at all age and ability levels, and a positive and significant association between perceptual ability and age.

REFERENCES

1. Adkins, C. D., & Lyerly, S. B. *Factor analysis of reasoning tests.* Personnel Res. Section Rep., no. 878. Washington, D.C.: Adjutant-General's Office.
2. Botzum, W. A. A factorial study of the reasoning and closure factors. *Psychometrika,* 1951, 16, 361–386.
3. Guilford, J. P., & Lacey, J. T. (Eds.). *Printed classification tests.* Army Air Forces Aviation Psychol. Program Res. Rep., 1947, no. 5. Washington, D.C.: U.S. Government Printing Office.
4. Mooney, C. M. A factorial study of closure. *Canad. J. Psychol.,* 1954, 8, 51–60.
5. Mooney, C. M., & Ferguson, G. A. A new closure test. *Canad. J. Psychol.,* 1951, 5, 129–133.
6. Street, R. F. *A Gestalt completion test.* Teachers Coll., Columbia Univer. Thesis, 1931, no. 4.
7. Thurstone, L. L. *A factorial study of perception.* Chicago: Univer. of Chicago Press, 1944.
8. Thurstone, L. L. *Mechanical aptitude III: Analysis of group tests.* Univer. of Chicago Psychometr. Lab. Publ., 1949, no. 55.
9. Verville, E., & Cameron, N. Age and sex differences in the perception of incomplete pictures by adults. *J. genet. Psychol.,* 1946, 68, 149–157.

AGE DIFFERENCES IN EMPATHIC ABILITY AMONG CHILDREN[1]

NEAL BURNS AND LORNA CAVEY

McGill University

THE PRESENT INVESTIGATION is concerned with the empathic ability of children from 3 to 6½ years of age. Several studies of child behaviour offer clues as to how empathy should develop through this age period. There is fairly general support, for example, for Piaget's (4) description of the 3-year-old as autistic and egocentric. Bridges (1) found that social adjustment in nursery school children "between the ages of 2 and 5 years . . . progresses from being socially indifferent . . . through stages of self-assertiveness and interference with the liberty of others, to a stage in which they show consideration, sympathy and kindness for others."

In our experiment, nursery school children were asked to describe the feelings of children depicted in familiar situations. In the light of the above opinions, we expected that children between the ages of 3 and 5 would be egocentric in Piaget's sense, and relatively incapable of recognizing how others feel in a certain situation. On the other hand, children between 5 and 6½ should display a higher level of social sensitivity and hence some degree of empathy. To test these predictions, a set of pictures was prepared to enable us to determine whether the child correctly inferred the feelings of a portrayed figure in a particular situation (empathic response) or imputed to the figure what his own feelings would be in that situation (egocentric or autistic response).

METHOD

Subjects

We used 39 Montreal nursery school children (19 boys and 20 girls) between the ages of 3 and 6½ as Ss: a younger group (under 5 years of age, $N = 22$) and an older group (over 5, $N = 17$).

Materials

Two sets of pictures illustrating children in familiar situations were used, one for boys and one for girls. Each set contained 8 pictures, 4 crucial and 4 non-crucial (or filler) pictures. The themes of the pictures used were:

[1]This research was first reported at the 1956 Annual Meeting of the Canadian Psychological Association, and was supported by grants from the Ford Foundation and the National Research Council of Canada to Dr. D. O. Hebb. In addition, we wish to thank Dr. W. E. Lambert and Miss Sondra Greenberg for their help in preparation of the manuscript.

Non-crucial

Boys' set	*Girls' set*
1. Boy catching a fish	Girl pushing a doll-carriage
2. A drawing board and paints	A drawing board and paints
3. Boy building a snowman	Girl skipping rope
4. Desk and chair in class-room	Desk and chair in class-room

Crucial

A_1 Birthday party scene with cake and presents

A_2 The birthday scene depicted in A_1 with the addition of a boy with a frown on his face

B_1 A doctor with a long needle in his hand standing behind an *empty* chair in his office

B_2 The scene depicted in B_1, with the addition of a boy with a smile on his face sitting in the chair

The set of crucial pictures for the girls was the same as above except that the figures represented were girls. Figure 1 is a sample of the pictures used.

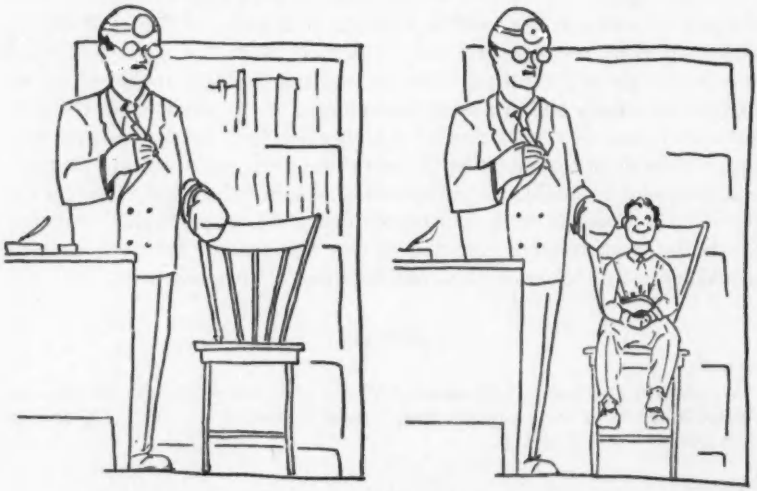

FIGURE 1. Sample pair of pictures (B_1 and B_2, boys).

Procedure

To ensure that the testing situation would be a relaxed one, the teacher informed the children that they would participate in a game to be played the next day. On the test day, the experimenter presented the pictures, one at a time, alternating filler pictures with crucial pictures as follows: 1, A_1, 2, B_1, 3, A_2, 4, B_2. Each picture was briefly described as it was presented. The subject was then asked one question

regarding the depicted situation. For example, the question for picture A_2 was: "Here is a girl (boy) at her birthday party. How does she feel?" The two "empty" or situation pictures (A_1 and B_1) were shown in order to ascertain the subjects' personal reactions. For example, for A_1, the subject was asked: "How would you feel if this were your birthday party?" Questions were also asked for the filler pictures in order to keep procedure uniform and aid *rapport*, but the answers were not used in this study.

To ensure that responses were not due to the order of presentation, half the subjects were shown the pictures containing figures (A_2 and B_2) *before* the empty pictures (A_1 and B_1). No differences in response occurred between the two orders of presentation, indicating that the differences between the groups could not be attributed to some differential effects of set.

The average time of observation was 4 minutes per subject, and all responses to the crucial pictures were recorded verbatim.

Results

Table I shows the number of subjects in each age group making 0, 1, or 2 "empathic" responses, that is, accurately describing the feelings of the portrayed child in pictures A_2 and B_2. The null hypothesis that empathic responses are not related to age was tested with Chi-square and rejected at the .001 level.[2]

TABLE I

Number of Empathic Responses Made to Pictures A_2 and B_2 by Younger and Older Groups

Groups	*N*	Number of empathic responses		
		0	1	2
Younger (under 5 yrs.)	17	8	8	1
Older (over 5 yrs.)	22	2	7	13

$\chi^2 = 13.94$; $p = .001$

To ascertain whether the differences observed were real or merely results of lack of *rapport* with the younger group, the responses given by each group to the empty pictures, A_1 and B_1, were compared. It was found that both groups gave essentially the same number of positive responses to picture A_1 and negative responses to B_1. (A typical positive response to A_1 for both groups would be: "Yes, I would like it to be my birthday party. You get nice presents at a party.") This high similarity suggests that there were no problems of communication with the younger group.

[2]It would have been interesting to correlate the occurrence of empathic responses with the age of the subjects; unfortunately the data did not lend themselves to such treatment.

Discussion

The present study found a significant difference in empathic ability between the two groups. The younger subjects generally failed to perceive the incongruous expression of the faces in pictures A_2 and B_2, while the older ones realized from the facial cues that the children depicted were not experiencing the feelings which the subject himself would feel, as indicated by his responses to pictures A_1 and B_1. For example, if the response to picture A_1 (the birthday party) was positive, the empathic response to A_2 (birthday party plus child with frown) would be negative.

Our data are consistent with Murphy's (3) statement that 3-year-old children have difficulty in differentiating themselves from others. Piaget (4) claims that at first the child considers himself and his position in the "universe" as absolute. This egocentricity seems to be related to Murphy's concept of self-differentiation and finds some support here, in that the 3-year-olds usually judged pictures A_2 and B_2 in terms of what they would feel themselves, rather than in terms of the cues presented. These egocentric responses, involving as they appear to do the child's inference that the perceived other feels as he would in that situation, may well be equated with the "assumption of similarity" referred to by Gage, Leavitt, and Stone (2).

Summary

The empathic ability of 39 nursery school children was tested by questioning them about a set of pictures. The number of empathic responses given by younger subjects (ages 3 to 5) was significantly lower than the number of such responses given by older subjects (ages 5 to 6½). These results are interpreted in terms of the views of Piaget and others on childhood egocentricity.

REFERENCES

1. Bridges, K. M. B. *Social and emotional development of the preschool child.* London: Routledge, 1931.
2. Gage, N. L., Leavitt, G. S., & Stone, G. C. The intermediary key in the analysis of interpersonal perception. *Psychol. Bull.*, 1956, **53**, 258–266.
3. Murphy, Lois B. *Social behavior and child personality.* New York: Columbia Univer. Press, 1937.
4. Piaget, J. *The child's conception of the world.* New York: Harcourt, Brace, 1929.

VERBAL ORGANIZATION IN THE LINES TEST

B. M. SPRINGBETT

University of Manitoba

THE PRESENT REPORT follows from an earlier investigation (1) in which a test of immediate memory, called the Lines Test, was proposed as an approach to the measurement of creative thinking. It represents a necessary preliminary step toward the empirical validation of the test and, at the same time, provides a re-testing of the general hypothesis.

On the assumption that creative thinking involves some unconscious factors, it was argued in the first article that conventional tests of reasoning and intelligence fall short of engaging the creative process, and that a test of creative thinking must meet the following requirements: (*a*) the task (problem) presented must be in the form of elements which permit organization (possess relations), but the directions in the test must not give any hint that such organization exists; (*b*) the elements of the problem must be capable of being presented in such a way as to make the eduction of relations difficult; (*c*) the various elements must be presented one at a time, so that they can be simultaneously present to the subject only ideationally; (*d*) the test must yield some measure of the interaction of conscious and unconscious processes.

There follows a factual description of the test used in the present investigation. Its conformity to the above requirements will then be shown and its rationale briefly outlined.

THE LINES TEST WITH VERBAL ORGANIZATION

Figure 1 shows nine test figures. Column (*a*) shows three words, NUN, COIL, COW, printed with 9, 10, and 11 straight lines respectively. These items possess verbal organization. In column (*b*) these words are shown again, but in a distorted form which conceals their organization. Column (*c*) shows three configurations, of 9, 10, and 11 lines, which are "nonsense figures" so far as verbal organization is concerned. All test figures are drawn on a 3×8 grid.

To the subject the task is presented as one of immediate memory. The test sheet for the word NUN is made up of nine 3×8 grids arranged vertically in step-wise fashion. On each grid is drawn *one* of the nine lines which make up the word. The order of the lines (top to bottom) is not the order usually used in printing the word but is jumbled. The subject is given 20 seconds to study the sheet and is then allowed 40 seconds to

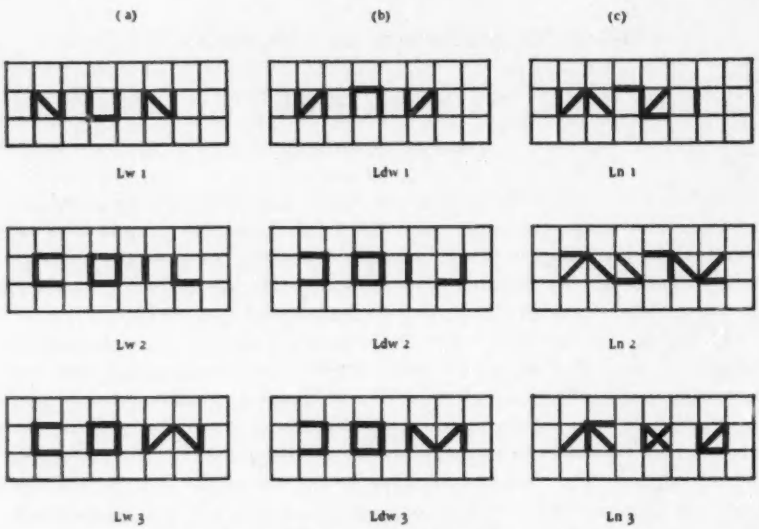

FIGURE 1. The Lines Test with Verbal Organization.

reproduce as many lines as he can on a single grid. If he remembers them all he will reproduce the word NUN.

Each of the nine test figures is so presented. The order in which the lines of each word are presented is duplicated exactly in the corresponding distorted words, and as nearly as possible in the corresponding nonsense figures. The score for each test figure is the number of lines correctly reproduced.

The three test items involving words (*LW*) fulfil the requirements of a test of creative thinking as outlined above. The elements (lines) do have an organization (verbal), but the subject is given no indication that it exists. The elements are presented in an order which makes it difficult to educe the over-all relations. Because of the time limits and the stepwise arrangement of the grids, each line is viewed separately. Since no subject (as yet) has been able to reproduce all the lines of any test figure, we may infer that no subject was conscious of the over-all organization.

The distorted words (*Ldw*) and nonsense figures (*Ln*) serve primarily as controls. As stated below, it is postulated that the organized figures provide a test related to verbal intelligence. The distorted words serve as a severe check on the hypothesis because they provide, element by element, an almost complete replica of the meaningful figures, contain recognizable letters, vaguely suggest words, but lack any over-all

meaningful organization. The nonsense figures contain no recognizable letter forms, and possess no over-all meaningful verbal organization.

Rationale

Detailed treatment of the rationale has been given elsewhere (1). In brief, the presence of a hidden organization is assumed to arouse processes of which we are not conscious. It is assumed that the creative thinker is sensitive to such processes. Creative thinking is viewed as differing from problem-solving only in degree, as the present test differs only in degree from conventional tests of reasoning and intelligence. Hence it is expected that scores on the meaningful figures will show substantial correlation with tests of verbal intelligence, the distorted words less correlation, and the nonsense figures least.

The original Lines Test employed geometrical organization; that is, the three meaningful figures were: a box, a prism, and a chair. There were, in addition, three gestalt figures (symmetrical but not easily named) and three nonsense figures composed of amorphous sets of lines which enclosed no space. It was assumed that, because the meaningful figures could be named, part of their score variance could be attributed to a verbal factor. The results produced some evidence for this assumption, but it was far from compelling.

It was felt, therefore, that before attempting empirical validation of the Lines Test as a measure of creative thinking it was necessary to produce variant forms which could be employed in different fields of creativity: for example, a verbal form for those who were creative in the field of literature.

The present purpose is, therefore, twofold: (*a*) to prepare a variant form of the Lines Test which may be empirically tested in those fields of creativity primarily involving the use of words; (*b*) by changing the nature of the organization in the test-items, to reassess the general hypothesis underlying the test. With the use of verbal organization, the hypothesis demands that scores will be predictive of verbal intelligence.

In the original test, those items to which a name could be attached correlated with verbal intelligence barely at the 5 per cent level of significance, and all other items failed to produce significant correlations. With the present unmistakable verbal organization in the Lines Test, failure to produce significant correlations with verbal intelligence would mark the inadequacy of the hypothesis or, at the least, of the present techniques for testing it.

Procedure

The Lines Test (Figure 1) was administered to 81 university students using the procedures described above. In separate sessions 2 other tests were administered:

(*a*) the *Henmon-Nelson Test of Mental Ability*, (*b*) the *Word Fluency Test* from the *S.R.A. Test of Primary Mental Abilities*.

Three scores were obtained from the Lines Test: (*a*) those based on items containing words (*Lw*); (*b*) those based on distorted words (*Ldw*); (*c*) those based on nonsense figures (*Ln*).

The *Henmon-Nelson* test was used because with economy of time three types of scores could be obtained: (*a*) those based on verbal items (HV), (*b*) those based on geometrical analogies (HS), (*c*) those based on number series (HN).

The Word Fluency test (*WF*) was chosen as representing, at the verbal level, the free play of association assumed to be a part of creative thinking.

Results

Table I shows the product-moment correlations between scores on the Lines Test and scores on the criterion tests.

As the primary aim in the experimental design was to display the effects of the verbal organization in the Lines Test, chief interest is focussed on the relation between the three types of scores on the Lines Test and those of verbal intelligence.

TABLE I

Product Moment Correlations between Scores on the Lines Test and 4 Criterion Test Scores

Lines Test	Criterion tests			
	HV	WF	HN	HS
Lw	.414***	.333**	.442***	.583***
Ldw	.252*	.341**	.331**	.409***
Ln	.198	.194	.352**	.486***

Level of significance: *** .001; **.01; *.05.

Column HV, Table I, shows a pattern of correlations in line with the hypothesis. *Lw* scores, based on a test with hidden verbal organization, show a correlation with verbal intelligence significant at the .001 level; *Ldw* scores show a correlation significant at a little better than the 5 per cent level, while *Ln* scores, based on nonsense figures (in terms of verbal organization), fail to produce a significant correlation. There is strong evidence that it is the over-all verbal organization (of which the subject never becomes aware) which accounts for the correlation with verbal intelligence.

With respect to the relation between the Lines Test and Word Fluency (column WF), *Ln* scores again fail to produce a significant relation, but *Lw* and *Ldw* scores show nearly equal correlations at the .01 level of significance.

Columns HN and HS show that with respect to number and space relations *Lw* scores still have the most substantial correlations, but *Ln* scores are also significantly related to these measures of intelligence.

Discussion

The present form of the Lines Test was designed to test the general hypothesis in relation to verbal intelligence. The results are clear and consistently in line with the hypothesis.

In relation to Word Fluency (WF) the results are in the main predictable. *Ln* scores fail to produce a significant correlation; *Lw* scores are significantly correlated, but at a level lower than that between *Lw* and verbal intelligence (HV). This result should occur since word fluency represents only one aspect of the creative process. Why *Ldw* scores should produce correlations as high as do *Lw* scores is not clear.

That *Lw* and *Ldw* scores should produce significant correlations with scores on number ability and space relations is not surprising. Elements in the test figures may be interpreted as numbers, accounting in part for the relation with number series scores, and the letters are represented by squares, angles, and other familiar geometrical forms.

The significant correlations of *Ln* scores with number ability and space relations may appear to be a discrepant result, since the nonsense figures in the original test correlated significantly with none of the criterion tests. However, in the original test the nonsense figures were spatial nonsense, that is, they enclosed no space. In the present test the nonsense figures are nonsense only in relation to verbal organization. Some do enclose space, and others form major parts of familiar figures; there are also forms which may be interpreted as numbers. In so far as these conditions hold, the significant correlations with space and number, together with the lack of such correlations with verbal intelligence, may be counted as confirmation of the hypothesis.

One other factor, common to all scores on the Lines Test, may account for part of their correlation with number ability. Many subjects use some sort of number system in recalling the location of the lines; those who are adept in this may be expected to do well on number series.

Summary

In an initial study (1) a test of immediate memory (the Lines Test) was proposed as an approach to the measurement of creative thinking. The present study offers a modified form of the Lines Test involving verbal organization. The prediction is that it will be related to verbal

intelligence in the same way that the original test was related to reasoning involving spatial relations. The prediction is confirmed.

REFERENCE

1. Springbett, B. M., Dare, J. G., & Clake, J. An approach to the measurement of creative thinking. *Canad. J. Psychol.*, 1957, 11, 9–20.

EFFECT OF MORPHINE ON THE EXPLORATORY DRIVE[1]

HORACE D. BEACH

Dalhousie University

THE ACTION OF MORPHINE on the organism is complicated by the fact that effects are produced at all levels of the neuraxis and these effects may be either depressant or stimulant in nature. Moreover, the depressant and stimulant effects may occur concurrently in different parts or successively in the same neural areas, with the stimulant effects almost always succeeding the depressant reaction. In spite of these complications, however, morphine's stimulant action has been associated with a number of effects on behaviour in a way that suggests how morphine may be involved in learning.

Joel and Ettinger (6) found that morphine gave rise to augmented "startle" reactions to sudden auditory and tactile stimuli in the rat. Wikler (16) observed a similar effect in cats, and noted that this type of reaction was a delayed phenomenon and not to be identified with the drug's initial depressant effects. With large doses (10–15 mg./kg. body weight) the "startle" reaction was progressively enhanced over a period of four to six hours after injection. Since tolerance develops to depressant effects while stimulant effects tend to be cumulative, it appeared that the "startle" phenomenon was one aspect of the drug's secondary stimulant action.

Another and probably related observation is that morphine produces increased distractability in cats (16) and chimpanzees (15), as if morphine made the animals hypersensitive to environmental stimuli and prevented adaptation to them. It has also been found that morphine exerts a selective action upon the organism's habit systems. In both cats (18) and dogs (17) it was observed that morphine tends to bring out and accentuate that behaviour pattern which was most predictable for a given animal in the experimental situation under normal conditions. For instance, recently induced neurotic behaviour gave place to adaptive food-habit responses four to six hours after morphine injection, while in animals which had exhibited neurotic behaviour often for as long as two

[1]This study was done at the McGill University Psychological Laboratory and was supported by grants to Dr. D. O. Hebb from the Rockefeller Foundation and the Foundations Fund for Research in Psychiatry. Portions of this study were included in a paper read at the annual meeting of the Canadian Psychological Association in Halifax, 1955. Grateful acknowledgment is made to Dr. Hebb who stimulated these studies and to Dr. J. Havelka for kind assistance.

years morphine abolished recently established adaptive responses and reinstated the neurosis. Finally, a previous study by the author (2) showed that morphine prevents the extinction of a food habit which eating normally produces, and does this maximally when the drug is acting *while* the animal is having commerce with the stimuli which evoke the food habit.

These findings on startle, distractability and habit function suggest a common hypothesis about one of morphine's effects on the organism: the drug tends to lower perceptual thresholds, thus increasing the arousal value of stimuli and tending to prevent adaptation to them. This hypothesis was tested in the following experiment by comparing the exploratory or curiosity behaviour of morphinized rats with that of a control group of animals.

Method

Male hooded rats approximately 100 days old were procured from the Royal Victoria Hospital colony for this study. They were divided into 3 groups with 6 rats in each group, group M to be tested in a morphinized condition, group H to be tested in a hungry condition, and group C to serve as controls. The Hungry group was included to determine if the hunger drive would affect exploratory behaviour in the experimental situation. Each group was housed in its own cage with water and food constantly available. The rats were tamed by being placed on a stand and handled frequently for two 30-minute periods daily for four days.

The apparatus and procedure were similar to those used by Berlyne (3) in a study of curiosity and exploratory behaviour. The apparatus consisted of an exploration box, 3 one-inch iron cubes, a solid iron cylinder of one-inch dimensions, a 3-channel ink recorder, and 3 non-locking push-button switches. The exploration box was 14 by 24 inches and 5 inches deep. It was covered with a hinged wire-mesh top and painted flat gray. The 3 cubes were black and the cylinder was white except for a ¾-inch brown bull's eye in the centre of each end. The switches and ink recorder were so wired and attached that the experimenter could manipulate each pen by pressing the appropriate switch.

The procedure for measuring the amount of exploratory behaviour and rate of adaptation to novel stimuli consisted of the following successive steps:

(1) Rats were placed in the empty exploration box by twos for one hour. Each rat was treated individually for the remainder of the procedure. (2) The rat was placed in the empty exploration box for 10 minutes. (3) Rat was replaced in home cage for 10 minutes. (4) With the 3 cubes placed 3 inches apart and 12 inches from the starting end of the exploration box, the rat was placed in the starting end of the exploration box and left for 5 minutes; the time spent exploring the 3 cubes during this period was recorded using the push-button and ink recorder hook-up. (5) Rat was replaced in home cage for 10 minutes. (6) Rat was given a second 5-minute exploratory period as specified in (4). (7) Rat was again replaced in the home cage for 10 minutes. (8) Rat was given a third 5-minute exploratory period in the box as in (4) with one of the cubes replaced by the cylinder (cylinder varied from right to left to middle position from rat to rat).

Control group rats were subjected to the above procedure without any change in their daily routine. Group H rats were deprived of food overnight—approximately 16 hours—and then tested. Group M rats were given an intraperitoneal injection of

5 mg./kg. morphine sulphate 24 hours before the experiment, and again 30 minutes before testing. This group was tested after a second dose of the drug because rats seemed to suffer some shock effects after their first dose.

Results

Each rat's exploration time per cube (in seconds) was calculated for each of the exploration periods, and from these times group averages were computed. Group averages were also calculated from times spent exploring the odd object (cylinder) which was introduced in the third period. Finally, a measure of the extent or rate of adaptation which occurred to the cubes was determined by relating the amount of exploration in the second period to the amount in the first period, using proportions: second period times divided by first period times.

It is apparent from Table I that rats receiving 5 mg./kg. of intraperitoneal morphine showed significantly more exploratory behaviour

TABLE I

Amount of Exploration and Rate of Adaptation to "Novel Object" Stimuli by Morphinized (M), Hungry (H), and Control Rats*

Group	Time exploring cubes			Odd object	Adaptation proportion
	1st period	2nd period	3rd period		
M	14.5	4.3	1.8	10.6	0.29
H	9.6	2.4	1.0	5.1	0.25
C	6.7	1.0	0.6	3.1	0.15
t(M *vs.* C)†	3.120	6.111	3.158	3.125	2.510
p	.02	.001	.02	.02	.05

*Figures in first 4 columns are mean times (in sec.) per object that rats spent exploring; column 5 figures are mean proportions: second period times divided by first period times (N for each group: 6).

†Differences between C and H and between M and H were not significant at the .05 level of confidence.

than did controls (p .02 for all exploration periods). Furthermore, adaptation was initially less rapid in morphinized animals, in the sense that they continued to explore the same cubes in the second exploration period proportionately more (p .05) than did the control rats. This differential change in "arousability" ceased to be significant by the third exploration period. The morphinized rats also explored consistently more than the hungry rats, but the difference was not significant. The hungry rats explored consistently more than the controls, but the difference between these two groups was never significant, owing, perhaps, in part to the small number of subjects. This finding with hungry rats is in contrast

with Montgomery's (10) study in which hunger or thirst decreased the amount of exploratory behaviour in a simple Y-maze. The discrepancy may be a function of the experimental situation in that the novel stimuli in the present experiment—cubes—could be manipulated. They could be touched and handled like a pellet, and were actually moved a little by some rats.

Discussion

The data from this experiment indicate that morphine leads to an increase in the amount of exploratory behaviour in rats under the conditions set up. The results are equivocal in one respect: a previous study (2) showed that morphine also leads to an increase in general activity. Hence the apparent increase in exploratory activity may have been a function of augmented activity level. However, other studies and observation suggest that increased exploratory behaviour is a direct result of morphine's action and not secondary to increased activity. First, Montgomery (9) has reported evidence that the exploration and activity drives are independent. Second, morphine enhances both startle and distractability in animals (15, 18), and both must be largely functions of reactivity to stimuli. Third, it was the author's impression that the increased activity under morphine (2) was due in large part to enhanced perceptual reactivity: the rats moved about as if being subjected to continual mild startle, each movement leading to some motion of the activity cage which in turn induced another mild startle reaction. Moreover, in the present experiment the morphinized rats exhibited augmented exploratory behaviour in terms of active commerce with the novel cube objects which were introduced to the exploration box. They also showed typical exploratory adaptation by a progressive decline in exploratory behaviour from period to period. It may therefore be reasonably concluded that morphine does augment exploratory behaviour in the face of novel stimuli, and that it slows adaptation to them.

These findings raise the problem of the nature of the processes underlying exploratory behaviour. Researchers thus far have assumed some unique drive, the *exploratory drive*, to account for curiosity and exploratory behaviour. This was "explanatory" in the sense that it related the phenomenon to such other types of behaviour as hunger and thirst. However, Montgomery's (8) studies have shown that exploratory behaviour does not obey the laws accepted by the Hullian school (5) for behaviour which is a function of a drive. He found that reactive inhibition could not account for exploratory alternation in a simple maze. He also established that a novel situation may act as a reinforcing agent in that rats learned a Y-maze problem and a black-white discrimination in order to arrive in the novel situation (11, 12). This implies that the animals

were seeking an *increase* in stimulation or drive, and it was inferred from decreased latencies in the Y-maze experiment that there was in fact an increase in drive. This is contrary to Hull's (5) central hypothesis that learning occurs when responses are contiguous with drive *reduction*.

The present series of studies on morphine (1, 2) have a bearing on the problems of both exploratory behaviour and drive-reduction learning. The experiment here reported indicates that morphine has some direct action which increases the amount of exploratory behaviour and slows adaptation to novel stimuli. This might suggest that morphine had induced a drive state. However, Montgomery (10) has shown that the classical drives of hunger and thirst do not increase, but rather decrease, the amount of exploratory behaviour, while rate of adaptation is essentially unchanged. On the other hand, a previous study (2) showed that the presence of morphine acts like a drive in that it prevents the extinction and the de-activation of a food habit which eating normally produced. Again, evidence was presented in the first of this series (1) that morphine may function to *reduce* a drive (the drive of morphine deprivation after dependence is established) and lead to learning. It is clear that these various findings are incompatible. The problem centres on the concept "drive," and the apparent incompatibility will disappear if we discard this concept and substitute concepts which convey a specific and operational meaning.

Thus the assumption that an exploratory *drive* underlies curiosity and investigatory behaviour would be rejected, and this class of behaviour would be conceptualized in terms of "threshold," "arousability," and "adaptation"—terms which, though specific in one sense, are yet more general than the classical "drive." Only one assumption would have to be made: that the organism tends to approach stimuli which are moderately arousing—an assumption which is borne out in experiment and everyday experience. On the other hand, the behaviour associated with needs like hunger and thirst would be placed in a separate category as it undoubtedly involves a different principle, that of need-reduction. Within this conceptual framework, then, there would be at least two levels of functioning, the perceptual and the homeostatic. They might proceed separately or concurrently, interacting or working in the same direction.

The various effects of morphine on behaviour found in the present series of studies (1, 2) could be handled by the above conceptual framework. In summary, it was shown that:

(1) When morphine is injected in physically dependent rats while they are suffering withdrawal symptoms, the rats acquire a durable preference for the place in which the symptoms were reduced.

(2) Rats acquired a preference for the place where they experienced the "euphoric" effects of morphine.

(3) Rats with a "morphine-seeking" habit exhibited that habit in performance whether they were "needing" the drug or freshly morphinized.

(4) Eating de-activated a food-seeking habit in rats; concomitant injection of morphine resulted in the exhibition of the food-seeking habit.

(5) Morphine made the food-seeking habit stronger when the drug was acting *while* the subjects were in the food goal box, eating and having commerce with the stimuli that normally evoked the habit, than when it acted while rats were eating in their home cages.

(6) Morphine led to an increase in exploratory behaviour and slowed adaptation to the novel stimuli involved.

The following hypotheses about morphine's mode of action are suggested to account for these findings:

(1) A series of doses of morphine leads to physical dependence on the drug whereby omission of a dose gives rise to "distressful" withdrawal symptoms. These symptoms represent a homeostatic upset which a further dose of morphine ameliorates. By inference, withdrawal symptoms signify a "need" for morphine, and a dose results in need-reduction. Such a mechanism would account for the learning of morphine-seeking behaviour in dependent subjects, as it would explain the observation that the morphine-seeking habit was exhibited in performance when the rats were morphine deprived.

(2) Morphine reinforces learning by some "euphoric" effect, possibly through some neural process like the "pleasure" area which Olds and Milner (13) discovered in the rat's brain.

(3) Morphine lowers perceptual thresholds, that is, increases arousability, and tends to maintain the lowered thresholds. This would explain the drug's effects on exploratory behaviour, as well as its action in maintaining the arousability of the morphine habit just after rats were morphinized and of the food habit just after the rats had eaten.

The last mentioned hypothesis might also account for the learning which occurred with "euphoric" reinforcement, in the absence of need-reduction. First, by tending to prevent adaptation to the goal box in which the rats were placed while morphinized, while the other goal box would be adapted to, the morphine goal box could retain its arousal value and continue to evoke the approach responses characteristic of exploratory behaviour. Second, by lowering and maintaining lowered thresholds morphine might facilitate the establishment of a more or less organized perceptual correlate of the morphine goal box which would be triggered like the perceptual component of any approach habit. That the drug has this active function is suggested by the fact that it made the food habit stronger when it was acting *while* the rats were having commerce with the stimuli that normally evoked the food-seeking habit.

Practically nothing is known about a possible neural basis for the need-reduction hypothesis. However, the problem is more hopeful with regard to the third hypothesis, that morphine lowers and tends to maintain lowered perceptual thresholds. A number of studies together suggest that the reticular substance of the brain-stem is the locus for first level perceptual functions and that morphine may have a facilitative action on the neural networks in that region. Lindsley (7) has reported evidence that the "startle" reaction is largely a function of the reticular substance. At the same time, several researchers (6, 16) have noted that morphine augments the "startle" reaction in animals. Sharpless (14) found, using an implanted electrode technique, that the reticular substance adapted or "habituated" in a stimulus-specific manner to the repeated presentation of a stimulus which initially produced mild startle. He suggested that excitation of the reticular substance produced a "dynamogenic" or facilitatory effect on new processes generally, and that this was the basis for exploratory behaviour. If this is true, morphine's effect on exploratory behaviour would appear to be due to the drug acting on the reticular substance in a way that lowers thresholds or increases arousability.

Direct evidence for morphine's effect on the reticular substance is not available. However, Wikler (16) observed that morphine (15 mg./kg.) had a diphasic effect on multi-neuron reflexes (ipsilateral flexor, crossed extensor and stepping movement): initial depression, lasting for one to two hours, followed by enhanced excitability which lasted for up to four hours. The same diphasic effects were observed in overt behaviour, with the difference that the initial depressant effect was of shorter duration while *cumulative* excitability was evident in the succeeding phase. Since the reticular substance is apparently composed of a network of internuncial chains, it is possible that this system would manifest similar effects, with the stimulant action accountng for morphine's effect on startle, habits and exploratory behaviour. The way in which morphine's anticholinesterase properties (4) might be involved is an open question. With regard to this hypothesis it should be noted that size of dose and timing of effects would be of crucial importance. This was found to be so in practice.

Summary

Three groups of rats were tested for amount of exploratory behaviour and rate of adaptation to novel stimuli. One group was given 5 mg./kg. morphine intraperitoneally before the test, the second group was deprived of food for sixteen hours before testing, and the control group was tested without any form of treatment. The morphinized animals explored novel cubes in an exploratory box significantly more than the

control rats, and adapted to the cubes significantly more slowly. The hungry rats were midway between the morphinized and control animals on both measures. The differences between morphinized and hungry rats on the one hand and between hungry and control subjects on the other hand were not significant. These results are discussed with reference to other known effects of morphine on startle, distractability and habit function. It is suggested that this group of effects is a function of some stimulant action of morphine on perceptual processes, specifically on the reticular substance.

REFERENCES

1. Beach, H. D. Morphine addiction in rats. *Canad. J. Psychol.*, 1957, **11**, 104–112.
2. Beach, H. D. Some effects of morphine on habit function. *Canad. J. Psychol.*, 1957, **11**, 193–198.
3. Berlyne, D. E. Novelty and curiosity as determinants of exploratory behavior. *Brit. J. Psychol.*, 1950, **41**, 68–80.
4. Bernheim, F., & Bernheim, M. L. C. Action of drugs on the choline esterase of the brain. *J. Pharmacol. exp. Therap.*, 1936, **57**, 427–436.
5. Hull, C. L. *Principles of behavior.* New York: Appleton-Century-Crofts, 1943.
6. Joel, E., & Ettinger, A. Zur Pathologie der Gewoehnung: III. Mitteilung—Experimentelle Studien ueber Morphingewoehnung. *Arch. exp. Path. Pharmak.*, 1926, **115**, 334–350.
7. Lindsley, Donald B. Emotion. In S. S. Stevens (Ed.), *Handbook of experimental psychology.* New York: Wiley, 1951, pp. 473–516.
8. Montgomery, Kay C. A test of two explanations of spontaneous alternation. *J. comp. physiol. Psychol.*, 1952, **45**, 287–293.
9. Montgomery, K. C. The effect of activity deprivation upon exploratory behavior. *J. comp. physiol. Psychol.*, 1953, **46**, 438–441.
10. Montgomery, Kay C. The effect of the hunger and thirst drives upon exploratory behavior. *J. comp. physiol. Psychol.*, 1953, **46**, 315–319.
11. Montgomery, Kay C. The role of the exploratory drive in learning. *J. comp. physiol. Psychol.*, 1954, **47**, 60–64.
12. Montgomery, Kay C., & Segall, Marshall. Discrimination learning based upon the exploratory drive. *J. comp. physiol. Psychol.*, 1955, **48**, 225–228.
13. Olds, J., & Milner, Peter. Positive reinforcement produced by electrical stimulation of septal area and other brain regions in the rat. *J. comp. physiol. Psychol.*, 1954, **47**, 419–427.
14. Sharpless, Seth. Role of the reticular formation in habituation. Unpublished Doctoral thesis, McGill Univer., 1954.
15. Spragg, S. D. S. Morphine addiction in chimpanzees. *Comp. Psychol. Monogr.*, 1940, **15**, no. 7, pp. 1–132.
16. Wikler, Abraham. Studies on the action of morphine on the central nervous system of cats. *J. Pharmacol. exp. Therap.*, 1944, **80**, 176–187.
17. Wikler, Abraham. Recent progress in research on the neurophysiological basis of morphine addiction. *Amer. J. Psychiat.*, 1948, **105**, 329–338.
18. Wikler, Abraham, & Masserman, J. H. Effects of morphine on learned adaptive responses and experimental neurosis in cats. *Arch. Neurol. Psychiat.*, 1943, **50**, 401–404.

THRESHOLD OF VISUAL RECOGNITION AND ITS RELATION TO HARMONIC EEG RESPONSE TO FLICKER[1]

R. L. D. WRIGHT[2] AND MARGARET A. KENNARD[3]

University of British Columbia

ONE OF THE FOUNDATIONS of Hebb's (3) neurophysiological theory of behaviour is the premise that the neurological aspects of attention, perception, perceptual generalization, and memory must be due to the development and patterning of large neuron nets, or assemblies. These are formed over a period of time by some growth process at the synapses, are particular to certain afferent sensory data, and serve some established efferent function. The effect of such a postulated process of growth would be a patterning of selectively raised and lowered synaptic resistances in both spatial and temporal dimensions; *perception* in these terms might be equated with complex conditioned patterns of cortical synaptic sensitization to afferent data.

One test of this postulate would be to determine whether ease or quickness of a perceptive process could be correlated with some physiological measure of synaptic sensitivity. Mundy-Castle (6) suggests that incidence of second and third harmonics in the EEGs of flicker-stimulated individuals may constitute such a measurement, and photic stimulation is widely accepted as a tool for the evaluation of cortical stability in many clinical conditions. The purpose of the present study was to determine whether, in fact, a relationship could be demonstrated in normal subjects between threshold of recognition for faint and brief visual stimuli and amount of harmonic response to intermittent photic stimulation modulated around the alpha frequency, as evidenced by analysis of the EEG frequency spectrum.

METHOD

Subjects and Apparatus

Fifty volunteer subjects, equally divided between the sexes, made up the experimental sample. The criteria for selection included age (17 to 30 years), visual acuity

[1]Based on a thesis submitted in partial fulfilment of the requirements for the M.A. degree at the University of British Columbia, 1956. The study was commenced under Federal Mental Health Grant No. 609–5–111 and completed under Defence Research Board of Canada Project D50–88–45–02.

The authors express their gratitude to the many individuals who assisted in the study, particularly to Dr. W. G. Gibson, Department of Neurological Research, University of British Columbia, and to his staff. The help of Dr. D. T. Kenny in the statistical design is also gratefully acknowledged.

[2]Now at the University of Toronto.

[3]Now at Mental Health Research Institute, Fort Steilacoom, Wash., U.S.A.

(20–25 or better), scholastic ability (all had completed high school or the equivalent), and absence of any abnormal neurological history. The purpose was to ensure constancy of sensory, intellectual, and cerebral conditions in the sample tested. Each subject was tested individually in a small lightproof room, with the following apparatus:

(1) Automatic 2 × 2 inch (35 millimetre) slide projector equipped with 500-watt lamp and tachistoscopic shutter. Shutter speeds ranged from 1.00 to .01 seconds; brightness was controlled at a constant level.

(2) Projection screen 2 feet square, consisting of a matt white surface surrounded by non-specular black field. Constant illumination of 10 foot candles was provided by two 60-watt lamps in reflectors 2 feet from centre of screen on horizontal axes of 45°. A fixation spot about 2 mm. in diameter was located in the centre of the screen.

(3) Ten photographically produced projection slides, which could be shown as faint white-line patterns on the illuminated screen. These are illustrated in Figure 1.

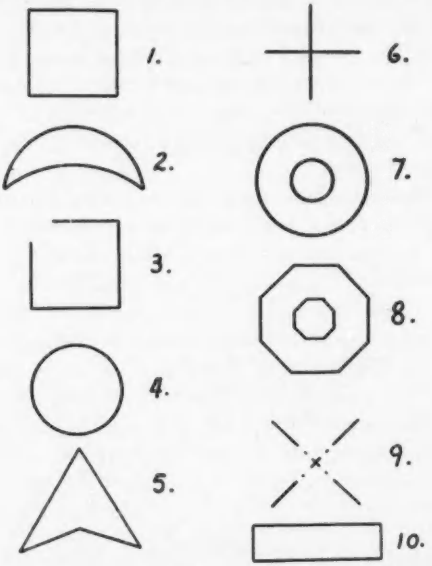

FIGURE 1. Stimulus patterns used in the determination of Recognition Thresholds.

(4) A Grass Model III-D electroencephalograph, connected with Offner Frequency Analyser, Type 830. EEG amplification was adjusted to the requirements of individual subjects; the analyser gain was constant at a setting of 7. Generally the EEG amplification was such that an absolute pen excursion with a 50 μv calibration force covered about 7 mm.

(5) A Grass Photo-Stimulator, Model PS-1, delivering a blue-white flash of 10 milliseconds duration at a peak intensity of about 190,000 candles.

Procedure

The "recognition threshold" (RT) of each S for each of the 10 patterns was obtained by presenting the series of slides a number of times, starting with the fastest

tachistoscope speed (at which no correct identification of patterns was possible) and increasing the exposure in each subsequent series until each pattern was correctly identified. This gave an "ascending" threshold; a "descending" threshold was obtained by reversing the procedure, and the two measurements were averaged to give a mean RT for each pattern. This value was expressed as its logarithm. The recognition threshold was thus defined as the logarithm of the shortest mean exposure time in milliseconds, in an ascending and descending series, at which S was able to make a correct identification of one stimulus object. The Mean Recognition Threshold (MRT) is the average of the RT's obtained for all 10 patterns during the complete test run, and constitutes the quantitative index of perception speed for each S. Scores thus obtained ranged from 1.000 to about 3.000; the reliability of this measurement was computed by the split-half method (Spearman r) to be 0.93. The characteristics of the pattern scores are shown in Table I.

TABLE I

MEANS AND STANDARD DEVIATIONS OF RECOGNITION THRESHOLDS (Log Milliseconds): $N = 100$

Pattern	Code	Mean	S.D.	Rank
1	Square	1.574	0.269	3
2	Crescent	1.582	0.359	4
3	Open square	1.793	0.374	8
4	Circle	1.569	0.338	2
5	Arrowhead	1.613	0.482	5
6	Plus	1.439	0.398	1
7	Doughnut	1.811	0.417	9
8	Octagon	1.622	0.352	6
9	Star	2.187	0.558	10
10	Rectangle	1.789	0.402	7
Mean	MRT	1.697	0.327	

In order to make the available range of tachistoscope shutter speeds discriminative, the intensity ratio of the basal pattern-background was found by pilot study and left constant for all experimental Ss. The pattern brightness against the illuminated screen was twice its average threshold level for unspeeded recognition; with this ratio the selective range of tachistoscope speeds was from 10 to about 500 milliseconds. Before the test runs were commenced S was shown each of the patterns on the screen for familiarization with shapes and names. A number of dummy patterns were included, to reduce the possibility of later guessing correctly from reduced cues.

Throughout the MRT runs S was seated 8 feet from the screen. Both eyes were used, and S was encouraged to relax the eyes and centre them on the fixation spot. Responses were made verbally.

Immediately following this procedure, S's EEG was recorded. Bipolar leads were arranged to record from the frontal, parietal, temporal, and occipital areas on both sides of the head. Electrodes were half-inch, 30-gauge hypodermic needles, cut short and suspended first in antiseptic solution. During recording Ss were seated in the dimly lit room with the eyes closed, as is conventional in obtaining maximum "resting" EEG potentials. During continuous recording on all 8 channels a frequency analysis was obtained for 3 epochs on each channel in turn; special attention was given to

the right occipital channel analysis, since this was to be the baseline for later determining the flicker response. This procedure gave a survey of the "resting" EEG frequency pattern, and a check on the absence of neuropathology. The stroboscope lamp was then placed 2 feet from the subject's face on an axis vertical to a point between the eyes. Continuous recording was resumed on all channels with analysis on the right occipital channel, and flicker was commenced at frequencies of 6, 8, 9, 10, 11, 12, 14, and 16 flashes per second, in that order, for 30 seconds (3 analyser epochs) at each frequency. An interval of 20 seconds separated each period of flicker.

The frequency analyser records were measured and graphed according to a method previously described (5). This consisted of ruling a baseline along each epoch selected for measurement, and measuring the vertical height of each pen deviation in millimetres by means of a transparent plastic template. In this way figures were obtained for the raw heights of pen deviations for each frequency between 3 and

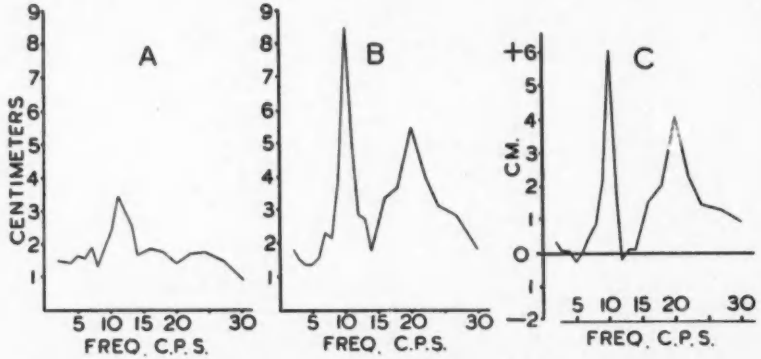

FIGURE 2. Method of charting EEG frequencies under experimental conditions: A, "resting" frequency analysis profile (right occipital lead only); B, frequency analysis profile obtained during 10 c./sec. flicker; C, flicker response B when resting frequency A is used as baseline. In practice it was found convenient to superimpose the profiles obtained from all flicker frequencies on graphs B and C, using different coloured inks for each.

30 c./sec. in each measured epoch; these were transposed to a graph upon which a number of frequency profiles could be superimposed. For each S 3 such graphs were constructed: one showing the "resting" profile of frequency pattern from each recording channel; the second showing the frequency profiles during each period of flicker, as recorded on the right occipital channel; and the third showing the arithmetically derived difference between the resting profile and each flicker profile. The construction of these graphs is shown in Figure 2. The third was the one used to determine the type and nature of the flicker response; an increase in activity at any frequency was indicated by a rise from the baseline, while a decrease showed as a lowering. Quantitatively, harmonic response was measured by adding arithmetically (plus or minus signs being retained) the distance from the baseline of the second, third, and fourth harmonics of all flicker frequencies whose multiples were repre-

sented on the frequency analyser. The Harmonic Index is defined as the sum of these distances in centimetres. Primary driving and sub-harmonics were not taken into consideration.[4]

Results

The correlation between recognition threshold and harmonic flicker response for the total group of fifty subjects was +0.27 by the Spearman rank order method. This was not significant at the .05 level (two-tailed test); thus the original hypothesis of a monotonic relationship between these variables was not supported.

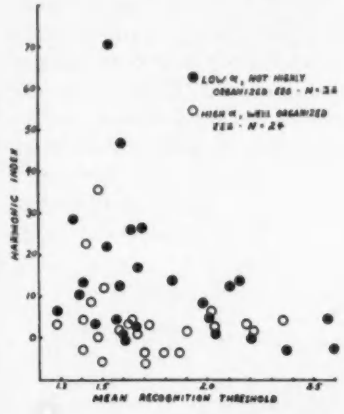

Figure 3. Relationship between Harmonic Index and MRT, comparing sub-groups established on criterion of alpha-organization.

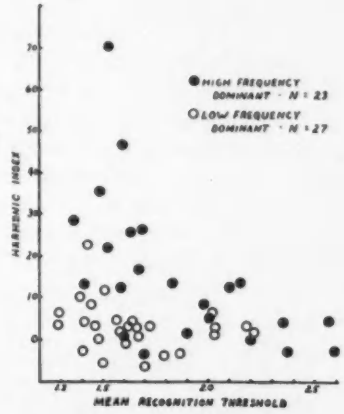

Figure 4. Relationship between Harmonic Index and MRT, comparing sub-groups established on criterion of frequency dominance.

The shape of the scattergram obtained (Figures 3 and 4) is qualitatively suggestive, in that it is definitely triangular rather than non-systematic. This was tentatively taken to indicate two "clumpings" of cases, one of them being fairly linear with respect to the hypothesized relationship, and the other being a cluster in the category of low recognition threshold and low harmonic response.

Examination of the resting EEG patterns in these two (hypothetical) clusterings indicated two factors which seemed to separate them to some

[4]Pains were taken throughout the study to check and maintain the EEG apparatus and to control calibration and amplification between subjects. None the less, the stability of the instruments remains unknown and some quantitative variance must be expected from this source. The qualitative findings would appear less subject to instrumental unreliability.

degree. The first factor was co-ordination of frequency pattern among the different recording scalp areas, as related to the amount of alpha activity characteristic of the resting EEG frequency pattern. These constitute two important criteria of EEG normality-abnormality (5, p. 32). When the 50 subjects were split into two groups of 24 and 26 on the basis of these criteria, the group having EEGs which were not tightly organized around a very high alpha index tended to show a better correlation between the two experimental variables, while the group characterized by high alpha indices and well-organized frequency patterns showed a generally low sensitivity to flicker throughout the entire range of recognition thresholds (Figure 3).

The second factor was the most dominant frequency of the subjects' EEG patterns; this distinguished the two clusters of cases more sharply. When the total group of 50 was split into two groups of 27 and 23 on the basis of frequency dominance, the sub-group with "high" dominant EEG frequencies (11 c./sec. or over) showed a highly significant correlation between the two experimental variables (Table II) while the group with dominant frequencies of 10 c./sec. or less did not (Figure 4). In neither case did the two factors produce significant sub-group correlation differences (Table II).

TABLE II

CORRELATIONS BETWEEN RECOGNITION THRESHOLD AND HARMONIC INDEX FOR TOTAL AND SUB-GROUPS

Group	*N*	*r*	sig.	Z	$SE_{diff.}$
Total	50	+0.27	>.05		
High alpha, well organized	24	+0.18	>.05	0.1872	0.075
					p .37 n.s.
Low alpha, less organized	26	+0.38	>.05	0.4001	
Low frequency dominant	27	+0.35	>.05	0.3700	1.410
High frequency dominant	23	+0.66	<.01	0.7946	*p* .07 n.s.

DISCUSSION

The factors which tend to produce separation of the scattergram clusters may be assumed from two theoretical bases. There is evidence which suggests that lowered threshold of cortical excitability is associated with a paroxysmal EEG and low alpha index (4). The converse, that good organization and high alpha index might be associated with a

relatively high cortical threshold to environmental stimulation, is suggested by this experiment. The second factor of frequency dominance follows from Mundy-Castle's suggestion (6) that individuals with dominant alpha frequencies above the mean of 10.3 c./sec. show higher cortical excitability characteristics, or in other words, lowered cortical threshold to excitation. This he relates to the temperament variables of *primary* and *secondary function*, the former being characteristic of "impulsive, quick, and variable individuals [who] tend to possess high alpha frequencies" and the latter of "cautious, slow, and steady . . . individuals [who] tend to possess low alpha frequencies" (6, p. 17). There seems some evidence that these temperament variables are related to excitability characteristics of the CNS (1, 2, 6, 7). It is possibly not accidental that both the "separation factors" of the present study are related to indices of cortical stability.

The design of this experiment does not justify any positive conclusions from the data, but the following hypothetical suggestions seem plausible.

It is possible that some factor of cortical stability precludes a marked harmonic response to flicker in subjects whose EEGs are tightly organized around a dominant alpha rhythm. The mechanism of this stability might be an overstringent pacemaker mechanism, which would resist extrinsic sensory effects on the EEG frequency pattern. This might be related to the temperament variables of primary and secondary function. The present findings suggest that a relationship between recognition speed and harmonic flicker response might become clearer in subjects whose EEGs are not so rigidly self-regulated. Such a possibility could be examined by duplication of this study on subjects pre-selected by the factors of frequency dominance and alpha-organization, or by some related criterion.

If recognition speed and harmonic index are related in subjects with characteristically sensitive EEGs, then it should follow that factors which increase EEG sensitivity (for example, metrazol or epinephrine) and those which decrease it (barbiturates or anaesthetics) would also selectively increase or decrease this relationship. This could be investigated by comparing these measurements on one individual under varying physiological and pharmacological conditions.

Summary

(1) This study undertook to determine whether speed of visual perception and degree of harmonic EEG response to intermittent photic stimulation were related through some mechanism of CNS synaptic sensitivity.

(2) A reliable procedure was evolved for measuring recognition threshold for simple geometric patterns. Correlation of this measurement with an objective index of EEG flicker response in a group of fifty young adult subjects did not indicate a statistically significant relationship.

(3) Inspection of the data showed that such a relationship did apply to roughly half of the subjects tested, and that these subjects had relatively high dominant EEG frequencies and relatively loose organization of frequency pattern with little or no alpha activity in the normal or low frequency ranges. Owing to limitations of data and method this relationship cannot be conclusively established by the present study.

(4) The possibility is discussed that the relation between EEG and perception may be masked by certain intrinsic EEG factors related to cortical stability under extrinsic stimulation.

REFERENCES

1. Biesheuvel, S. The measurement of threshold for flicker and its value as a perseveration test. *Brit. J. Psychol.*, 1938, **29**, 27–38.
2. Biesheuvel, S. An observational technique of temperament and personality assessment. *Bull. South Afr. Nat. Inst. Pers. Res.*, 1949, **1**, 9–27.
3. Hebb, D. O. *The organization of behavior.* New York: Wiley, 1949.
4. Kennard, M. A. The electroencephalogram in psychological disorders: A review. *Psychosom. Med.*, 1953, **15**, 95–115.
5. Kennard, M. A., Rabinovitch, M. S., & Fister, W. P. The use of frequency analysis in the interpretation of the EEGs of patients with psychological disorders. *EEG Clin. Neurophysiol.*, 1955, **7**, 29–38.
6. Mundy-Castle, A. C. An analysis of central responses to photic stimulation in normal adults. *EEG Clin. Neurophysiol.*, 1953, **5**, 1–22.
7. Wiersma, E. D. *Lectures on psychiatry.* London: H. K. Lewis, 1932.

EFFECT OF GLUTAMIC ACID ON THE LEARNING ABILITY OF BRIGHT AND DULL RATS: III. EFFECT OF VARYING DOSAGES[1]

K. R. HUGHES, R. M. COOPER AND JOHN P. ZUBEK

University of Manitoba

IT HAS PREVIOUSLY been reported that the learning ability of dull rats can be improved considerably as a result of daily feedings of 200 mg. of monosodium glutamate during infancy (1). Since an improvement in learning ability was obtained using an arbitrarily chosen supplement of 200 mg., it was of interest to determine whether a larger dosage might produce an even more marked improvement. The present study compares the effects obtained by feeding dosages of 200 mg. and 500 mg. of monosodium glutamate to dull rats.

PROCEDURE

Subjects. Forty-one hooded rats of the McGill dull strain (F_{12}) served as subjects in the experiment. They were divided into a control group of 14 rats, an experimental group of 15 rats and a second experimental group of 12 rats.

Apparatus. The 12 problems of the Hebb-Williams closed field maze were administered in the manner described by Rabinovitch and Rosvold (2).

Procedure. The 41 animals of the dull strain were weaned at 25 days of age, and both the experimental and control groups were placed on a normal colony diet (Fox chow pellets). In addition to this food, the experimental animals of group I were given 200 mg. of monosodium glutamate daily (in 5 grams of wet mash), those of group II were given 500 mg. of glutamate, and the controls received 5 grams of wet mash, but without any glutamate supplement. At 65 days of age the supplementary feeding was discontinued and the animals were tested on the Hebb-Williams maze. Error and time scores were recorded for each animal.

RESULTS

The mean error and time scores for the control and two experimental groups are shown in Table I. It can be seen that the experimental animals receiving 500 mg. of monosodium glutamate derived no benefit from this special diet, making error and time scores almost identical to those of the controls. On the other hand, the animals receiving only 200 mg. of the glutamate seemed to have benefited somewhat, making fewer errors than the controls. This difference, however, is not statistically significant ($p > .3$).

[1]This research was supported by a grant-in-aid from the Associate Committee on Applied Psychology of the National Research Council of Canada.

TABLE I

EFFECTS OF VARYING DOSAGES OF MONOSODIUM GLUTAMATE ON MEAN ERROR AND TIME SCORES OF DULL CONTROL AND EXPERIMENTAL ANIMALS

	Controls	Experimentals	
		Group I (200 mg.)	Group II (500 mg.)
Mean errors	172.8	160.5	172.2
Mean time (secs.)	509.4	550.7	513.0

DISCUSSION

The results obtained in the present study are anything but clear-cut. Perhaps the most surprising finding is in regard to the effects of the 200 mg. dosage of monosodium glutamate. Animals fed this dosage made fewer errors on the maze problems than did their litter mate controls, a finding which is in line with the authors' previous work (1) in which the same dosage was fed to two different groups of dull rats. In the present experiment, however, the difference was not statistically significant. This is a most puzzling finding, since the same experimenters were used throughout and exactly the same procedure was followed in all the experiments. The only difference in procedure was that in the present study F_{12} generation animals were used whereas in the earlier work F_{10} and F_{11} animals were employed. It is difficult to believe that this variable could be responsible for the discrepancy in results, especially since the error scores of the *control* animals of the three generations were approximately the same. Nevertheless, it is the most likely possibility. For example, if the *experimental* animals of the present study happened to be somewhat brighter (prior to glutamate feeding) than the experimentals used in the earlier work we would not expect much improvement in learning ability, for it was shown in an earlier study (1) that glutamic acid has no effect on the learning ability of bright rats. This possibility, although remote, is currently being explored.

Another surprising finding is that the 500 mg. supplement of monosodium glutamate had absolutely no effect on learning ability. One might have expected an improvement at least as great as for the 200 mg. dosage, or else, perhaps, an impairment of learning ability due to possible toxic effects of such a large dosage. The lack of any effect is puzzling. One possible explanation is that monosodium glutamate exerts a beneficial action only within a certain narrow range, with dosages above or below this range having no measurable effect.

It is obvious from these results that the action of glutamic acid on learning ability is not as simple as at first appeared and that numerous variables affect its operation, variables whose influence only future research can clarify.

Summary

The purpose of the present experiment was to determine the effect of varying dosages of monosodium glutamate on the learning ability of a strain of dull rats.

Forty-one dull rats were divided into a control and two experimental groups at the time of weaning and placed on a 40-day experimental feeding schedule. During this time group I ($N = 15$) received 200 mg. monosodium glutamate daily; group II ($N = 12$) received 500 mg. glutamate daily, while the control animals ($N = 14$) were given a placebo. At 65 days of age the animals were tested on the problems of the Hebb-Williams maze.

Animals fed 200 mg. daily averaged fewer errors than did the controls, but the difference was not large enough to be statistically significant. These results are inconsistent with those reported in an earlier study. The mean scores of animals fed 500 mg. of monosodium glutamate daily were almost identical with those of the control animals.

REFERENCES

1. Hughes, K. R., & Zubek, J. P. Effect of glutamic acid on the learning ability of bright and dull rats: I. Administration during infancy. *Canad. J. Psychol.*, 1956, **10**, 132–138.
2. Rabinovitch, M. S., & Rosvold, H. E. A closed field intelligence test for rats. *Canad. J. Psychol.*, 1951, **5**, 122–128.

COMMUNICATIONS

A PROPOS DE "LA LOCALISATION DES TESTS"

Le numéro de mars, 1957, du *Canadian Journal of Psychology* présentait "Une méthode rationnelle de localisation des tests dans les échelles d'âge" par Monique Laurendeau et Adrien Pinard.

Il est surprenant qu'on y passe sous silence une méthode déjà décrite en 1941, à Montréal même, par Lawrence Dayhaw, lors de l'étalonnage de son *Echelle de vocabulaire.*[1] La méthode est décrite au début du chapitre II et, à la page 19, une règle pratique est formulée. Cette méthode peut s'appliquer aussi bien aux sous-tests de l'échelle Stanford-Binet qu'aux mots d'une échelle de vocabulaire.

La méthode Dayhaw a l'avantage de ne pas fonder tout le calcul sur la prémisse que ". . . 50 pour cent des sujets . . . devront réussir tous les six tests (Laurendeau et Pinard, page 42), prémisse qui est proche parente du problème que les auteurs mettent à l'étude. De plus, la méthode Dayhaw ne postule pas nécessairement que tous les sous-tests d'un âge sont de difficulté égale, postulat qui semble inquiéter les auteurs (page 45). Elle permet les deux postulats: ou bien que les six sous-tests sont de difficulté égale, ou bien que les six sous-tests sont les échelons sucessivement gradués de l'échelle d'ensemble formée de tous les sous-tests.

Appliquons la méthode Dayhaw à l'âge de 8 ans. Là, les âges successifs représentent des changements de 12.5 points de Quotient Intellectuel ou de $.833\sigma$ (si l'on veut que $\sigma = 15$). La moitié de cet écart égale .416, point pivot d'où partent les autres échelons par crans de .833; c'est-à-dire .416, 1.25, 2.083 et 2.916 avec le signe plus dans un sens et le signe moins dans l'autre sens. Dans l'hypothèse que les six sous-tests sont d'égale difficulté, les pourcentages correspondants de réussite (voir table des probabilités) seront 100, 98, 89, *66*, 34, 11, 2 et 0. Remarquons que cette gradation n'est pas bien différente de celle que Laurendeau et Pinard publient à la page 43: 100, 98, 88, *63*, 32, 10, 2 et 0.

"Le nouveau, c'est souvent du vieux qui a été oublié!"

R. H. SHEVENELL

Université d'Ottawa

[1]Lawrence T. Dayhaw, *Une échelle de vocabulaire.* Bulletin no 4 de l'Institut pédagogique Saint-Georges, Université de Montréal, 1941.

Note sur la communication de Shevenell

A première vue la méthode sur laquelle Shevenell attire notre attention ressemble à celle que nous avons proposée, mais en fait les deux méthodes sont essentiellement différentes.

1. La méthode de Dayhaw a sûrement de grands mérites, mais elle est basée sur le principe des échelles en points et sert à distribuer les items inégalement difficiles *d'un même sous-test* entre deux niveaux d'âge ou d'habileté. Les problèmes étant tous de même nature, il faut (postulat) que la difficulté diffère si l'on veut éviter le double emploi. Notre méthode, basée sur le principe des échelles d'âge, vise plutôt à situer des *sous-tests variés* à un âge qui les caractérise tous également. (Il est évident que, si la corrélation était parfaite entre ces sous-tests, la multiplicité serait inutile.) Pour pouvoir dire que tous ces sous-tests, de nature différente, sont réellement assignables au même âge, il faut (postulat) qu'ils soient de même difficulté, si l'on veut donner le même crédit aux sujets qui les réussissent. C'est d'ailleurs pourquoi il nous semble que la méthode de Dayhaw, pas plus que d'autres que nous n'avons pas cru devoir signaler (celle de G. H. Thomson par exemple), ne peut servir à localiser les tests dans une échelle d'âge véritable.

2. La méthode de Dayhaw ne s'applique valablement que si la difficulté des tests assignés à un âge est différente, alors que notre méthode exige des sous-tests de difficulté égale. C'est pourquoi, dans l'exemple apporté par Shevenell, les calculs assument que tous les tests de l'âge de 8 ans n'en constituent qu'un seul et ce test est alors situé au milieu de l'intervalle considéré. En somme, suivant cette méthode, les pourcentages sont les mêmes quand on veut assigner seulement un test ou bien plusieurs tests de même difficulté à chaque niveau d'âge. Or, si l'on se réfère à notre article, on s'aperçoit que notre méthode implique une variation des pourcentages en fonction du nombre de tests à assigner, même si ces tests doivent être de difficulté égale. A 8 ans, par exemple, on obtient les pourcentages 100, 99, 95, 79, *50*, 19, 5, 1, 0, si l'échelle ne contient qu'un test par niveau d'âge, et les pourcentages 100, 98, 88, *63*, 32, 10, 2, 0, si elle en contient six. En fait, c'est surtout pour souligner l'importance de ce phénomène, jusqu'à maintenant négligé, que nous avons proposé notre méthode. Si, dans le cas proposé par Shevenell, les chiffres se rapprochent sensiblement des nôtres, c'est parce que l'exemple illustrant notre méthode comportait six tests par niveau d'âge et que, dans ce cas, il arrive que les résultats des deux méthodes coincident. Il suffirait simplement de diminuer ou d'augmenter le nombre de tests à réunir à chaque âge pour que les résultats obtenus par notre méthode s'éloignent

des chiffres de Shevenell qui, eux, sont définitivement fixés pour un niveau d'âge donné, quel que soit le nombre de sous-tests.

3. Notre méthode aurait le désavantage de se fonder sur la prémisse que 50 pour cent des sujets d'un âge donné devraient réussir tous les tests assignés à cet âge. Dès qu'on veut exprimer le développement mental, comme le fait d'ailleurs Dayhaw lui-même, en termes de quotient intellectuel, on ne voit pas comment il pourrait en être autrement dans une échelle vraiment transitive puisque, par hypothèse, tous les tests assignés à un âge sont de difficulté égale. D'ailleurs l'admission d'une telle prémisse ne présume en rien, contrairement à ce que laisse entendre Shevenell, de la solution du problème qui est de déterminer le pourcentage moyen à exiger *en fonction du nombre de sous-tests.* Ce pourcentage n'est de 50 que si l'échelle ne contient qu'un test par âge.

MONIQUE LAURENDEAU ET ADRIEN PINARD

Université de Montréal

BOOK REVIEWS

Interpretive Psychology: The Nature of Human Activity. By S. N. F. Chant and E. I. Signori. Toronto: McGraw-Hill Co., Ltd., 1957. Pp. x, 275. $5.00.

The publication in Canada by two Canadians of an introductory textbook is a notable event, almost a landmark, in the history of Canadian psychology. Comparison with the big-selling American texts is inevitable, and the venture may at first appear remarkable chiefly for a courage that borders on temerity. However, Canadian psychologists need feel no qualms about the performance of their colleagues. Chant and Signori have not only written a competent, balanced, comprehensive and readable book for the beginner but have given it an original slant of their own that confers upon it a distinctiveness and a special usefulness that fully justify its publication.

In its outward features *Interpretive Psychology* is about as unlike the fashionable "Life Magazine" type of text as one could well imagine. Printed in clear, well-spaced type, its normal size and weight mean that it can be lifted without one's having to brace oneself. No double columns jerk the reader's eyes back and forth, no glossy paper dazzles him, no cartoons, no photographs of teen-agers at play distract his attention, and there are no charts or figures, and practically no tables. The authors have also omitted "study aids," end-of-chapter summaries, and sets of questions and exercises. The references are given comfortably in footnotes, so that the reader does not lose his place hunting for them. There is no glossary, for the language is largely untechnical, and the reading lists are unostentatiously brief. In short, Chant and Signori have thumbed their noses at most of the conventions of contemporary textbook publishing. Perhaps they have allowed their zeal to carry them too far, but they have paid the student the old-fashioned courtesy of respecting his intelligence and maturity of interest and initiative.

What do the authors mean by "interpretive" psychology? No doubt every book on psychology interprets, though the interpreting may be concealed even from the author. Chant and Signori not only admit that they are interpreting, but they think that interpreting is important enough to be done intentionally and thoroughly. They deliberately take a line which is, broadly speaking, phenomenological, holistic, mentalistic and personalistic. They are against psychologism, mechanomorphism, reductionism and geneticism; they are in favour of wholeness, cognition, freedom, purpose, continuity, and the irreducible uniqueness of the human

and the personal. Although they seem to agree with the criticisms of certain tendencies in contemporary psychology expressed by Asch, Gordon Allport and others, they are scrupulously careful to point out the nature of divergent interpretations. They urge the student to study them and give him clear directions for finding them. The footnotes are occasionally recondite, but both they and the reading lists are remarkably catholic. In the author index Asch gets 16 references but Dollard and Miller get 15; Snygg and Combs get 14 but Skinner gets 12, and so on. Clearly the authors' intention is, while stating their own views, to encourage the student to form his own critical opinion, to think responsibly about psychology, to reflect on the meaning of what he is learning and to discover its significance in terms of human life. This attitude gives the book a substance and a dignity that must be unique among works of the same class. The authors have the courage to say things that are unpopular: that the educational value of movies and television is strictly limited, that the pervasive importance of sex has been exaggerated, that "the effects of early experiences are not normally as unalterable as is sometimes implied," that scientific methodology should not be allowed to restrict the scope of enquiry, and that science in general and psychology in particular have limits in the understanding of human activity, which should be drawn to the attention of students so that they may appreciate the relevance and importance of other sources of knowledge.

Some critics will jump to the conclusion that the scientific method itself is under attack in the interests of some vague and mystical concept of understanding, but it is only the limitations of scientific methodology that are pointed out and this is made quite clear on pages 12–13. Perhaps nearer the mark would be the observation that the treatment of details is too purely descriptive, that assertions sometimes appear unsupported by data, that not enough importance is attached to the logic of experimentation and the evaluation of evidence, and that the student has thus too much impressed upon him the importance of mere content, however derived, and its interpretation. However, it is poor criticism of a book to accuse it of failing to accomplish what it never set out to do. If by interpreting psychology Chant and Signori mean helping the student to relate it to other subjects, including not only the natural and social sciences but philosophy and religion, and to acquire a balanced sense of the significance and limitations of scientific psychology, and a reflective and responsible attitude to its uses and applications, then they have done something exceptional and important.

Practically all the topics ordinarily covered in an introductory text are dealt with, but rather as aspects of the activity of the person as a whole

than as separate processes. A few special points may be noted. Motivation is discussed in Part 2, but social motives are not mentioned until Part 6. Some will feel that the treatment of hunger and thirst suffers from over-simplification. On the whole the cognitive chapters (Parts 3, 4, 5) are particularly well done. The discussion of emotion (Part 8) is very useful in a practical way as are the accounts of adjustment and maturity (Parts 12 and 13). I found the treatment of sentiment in Part 9 somewhat confusing and unsatisfactory, though this may be a personal idiosyncrasy, and in the sentimental basis attributed to beliefs and moral principles the authors do not appear to have profited as much as one would have expected from Asch's demonstration of the requiredness and objective basis of values. The interpretation of human progress (pp. 54, 104, 138) may strike some as narrow, and the book is perhaps weakest in social criticism. Though sturdy individualists and strong defenders of the psychological value of individual freedom, the authors on page 239 seem to be advocating something strangely like conformism in the interests of individual mental health. They are often strong, however, just where many texts are most superficial. The treatment of the self in Part 12 is a valuable supplement to more conventional accounts of "personality." It is characteristic that "self" has more references in the index than any other term, with "emotion" next and "learning" a weak third. The final section on "The Transitional Nature of Human Activity" brings us to a somewhat abrupt termination. Because of the strong emphasis on "wholeness" we expect some final summing up and knitting together. Perhaps it was a mistake to put the chapter on development at the end. Part 12 might have made a more fitting conclusion and they could easily have changed places.

The writing is simple and clear, if at times a little pedestrian. The authors express the hope that the beginner will assimilate the stuff and matter of psychology in relation to his own experience and not just learn to parrot a vocabulary. But will he emerge from the study of *Interpretive Psychology* with a sound and thorough grasp of contemporary psychology? Two things may be said. A heavy responsibility is placed upon the lecturer to help the student over the gulf that separates the very concrete and everyday language of the text from the technical concepts and terminology of the works indicated in the footnotes and reading lists. Secondly, it is partly by suppressing technicalities that the authors have succeeded in giving the reader a more comprehensive grasp of general psychology as a whole and a greater sense of its unity and coherence (greater perhaps than the situation at the moment actually warrants) than any other comparable text.

There are a number of misprints though few of them are serious. The indexes occasionally betray one, and some of the books referred to in

the footnotes and reading lists have appeared in editions later than those mentioned. But these are minor blemishes which can easily be removed in the next impression.

F. HILTON PAGE

University of King's College

Lehrbuch der Rorschach Psychodiagnostik für Psychologen, Ärzte und Paedagogen (Text of Rorschach Psychodiagnosis for Psychologists, Physicians and Teachers). By DR. EWALD BOHM. Second edition. Berne: H. Huber (New York: International Medical Book Corporation), 1957. Pp. xxiv, 441. $10.50.

MANY CONTINENTAL INTELLECTUALS have come to expect that the most valuable European discoveries will be subject to apathetic reception at home, tremendous popular support as well as misinterpretation in America and, after a while, enthusiastic re-export of the unrecognizable monster to the perplexed mother continent.

This may be demonstrated with subjects ranging from atomic energy to psychoanalysis, and holds partially true for the Rorschach test. This test has suffered such changes in its Americanization that it is practically impossible for European Rorschach results to be compared with American. On the other hand, long before its American discovery, the Rorschach test had gained great popularity in Europe where it blossomed into a truly great, many-sided test, on more traditional but no less dynamic lines than the American version. Today, thirty-seven years after its birth, the Rorschach test ("European version") still stands as a unified system, successfully resisting the American import as well as the temptation to split into a dozen isolated schools. A proud demonstration of this fact is the present book, accounting for almost four decades of international development in the Rorschach test, and providing the fundamental manual of original Rorschach.

In the preface to this edition, the Danish author emphasizes that, although there has been a tremendous increase in Rorschach literature in the five years since the first edition, the proportion of results which could be incorporated into the Rorschach system and successfully used in practice has actually declined. Many papers have had to be discarded because their results could not be compared with those of the original Rorschach method. "There would be no sense in comparing results obtained by using completely different methods . . . only because they still happen to use some of the same scores. Even these have a different meaning." Although this split into different schools of "American" Rorschach has made the author's task in selecting and incorporating new

knowledge easier, "it is regrettable that so much valuable test material is lost for proper Rorschach research. . . . From the point of view of psychological research changes in technique in the different Rorschach schools could be justified only if they led to more reliable results. . . . This, in our opinion, still remains to be demonstrated for the many deviant techniques presently existing. It is our intention to continue to use the original method and to develop it along the lines of the vigorous and efficient Swiss tradition. This shall not prevent us, however, from taking suggestions from all sides . . . as long as these can be incorporated into Rorschach's framework."

The author keeps his promise of a really international textbook and the names of the better known American authors appear frequently. In contrast to this and as a sad example of increasingly exclusive sectarianism, in Klopfer's *Developments* (vol. I) only Schneider and Zulliger of Rorschach's closest co-workers are mentioned (twice each!), and of such international Rorschach pioneers as Bohm, Basch, Binder, Guirdham (in English!), Kuhn, Loosli-Usteri, Morgenthaler, Mohr, Merei, and Oberholzer not a single trace can be found. Even Hermann Rorschach is mentioned on only 14 pages as contrasted with 136 pages in Bohm's book.

The present manual is subdivided into five major sections. Throughout, a black vertical line on the margin indicates the principal parts for the beginner, providing a "basic Rorschach" of less than 125 pages for the first reading and leaving the details for the more advanced student.

The historical-systematic first section is followed by a second, technical part which present clear instructions for standardized administration and scoring. The latter is based on ideas of the Rorschach test which are conservative, yet modern in reflecting developments in keeping with the original method from all over the world. The "language" represented in this book is "spoken" today in many countries by a much greater number of clinicians than there are in any of the splinter schools. It is the international language of today's Rorschach test. The importance of this language for the maintenance of a basis of comparison in scientific research cannot be overemphasized, particularly for American psychologists. The scores are not gained by a "second test" of the inquiry situation (Bohm's advice on this question is: Less is more), but by standardized rules, a difference which not only saves time but greatly simplifies teaching and helps to maintain greater reliability. Besides the actual scores 71 unscorable "special phenomena" (or Specific Reactions as Merei calls them), most of which are completely unknown on this continent, are evaluated.

The third section deals with the elaborations of the test. After the ex-

planation of basic principles, there are rich chapters on the technique of quantitative and qualitative estimation of intelligence and on affectivity and social contact. The constitutional types and forms of psychopathy are subject to a positive approach. There are about 130 pages on Rorschach psychopathology with each form of psychosis receiving comprehensive treatment. Forms of neurosis are also carefully treated with a ready-tailored theoretical frame of reference. Results and problems of Rorschach work with children and with the aged are excellently summarized in the two closing chapters of this part—the latter a really valuable addition to the second edition.

The fourth part is a scholarly analysis of the theoretical foundations of the Rorschach test, such as the contributions of colour-form research, association experiments, and gestalt theory. The whole book, but this part in particular, is a gold-mine of new hypotheses for every psychologist who wants to do research on or with the Rorschach test. The fifth and final part contains illustrative examples; 31 protocols of normals of all intelligence levels and types, neurotics, psychopaths, and psychotics of all categories.

One of the changes in the second edition which this reviewer most warmly welcomes is a very positive attitude towards developments by the Merei Hungarian-Austrian school. Bohm comments favourably on Merei's dynamic approach which is based on Lewinian field theory, several Specific Reactions developed by this school, and the "Reality Index."

The only pity is that this truly great book is not yet available in English. An English edition is promised, but it may take longer to appear than is desirable. Meanwhile, every Rorschach interpreter on this side of the water who trusts himself to break through the language barrier might do well to add the German edition to his reference library. It will be the key to a lost world full of wonderful treasures well worth being re-discovered.

STEPHEN NEIGER

Toronto Psychiatric Hospital

Emotion and Meaning in Music. By LEONARD B. MEYER. Chicago: University of Chicago Press [Toronto: University of Toronto Press], 1956. Pp. x, 307. $5.75.

TO PSYCHOLOGISTS interested in music this is an exciting book to read. It is also a chastening one, for this professor of music, in applying some of our theories to his own field, reveals in them explanatory powers which few of us have recognized.

Meyer's problem is simply stated: what constitutes the meaning of music, and by what processes is it communicated? It is significant that, with the literature of aesthetics and musicology clearly at his fingertips, it is to psychology that he turns for his answers. On the whole, these answers are the most convincing yet given; where they leave any doubts, it is due to the inadequacies of psychological theory rather than to any lack of scholarship or insight in the author.

This is evident in the treatment of the emotional response to music, the least satisfying part of the book. As one would expect, Meyer finds our theories of emotion confusing; but working from his own position as a musician he succeeds in developing a solution which, if not final, is at least in line with much current work. Emotion is aroused, he says, when a response tendency is blocked or inhibited, and the affect itself must be regarded as undifferentiated—felt differences between emotions being due to awareness of the stimulus situation. Here Meyer is, of course, close to the "arousal" theory of Hebb, whom he quotes and also criticizes. Like Asch and Scheerer, however, Meyer rejects the dichotomy between emotion and reason; thinking and feeling are different aspects of a single psychological process which hinges on perception and the expectations based on learning. Hence the same processes which give rise to emotion are responsible for the intellectual meaning of music—expectation, suspense, and ultimate fulfilment. "If on the basis of past experience a present stimulus leads us to expect a more or less definite consequent musical event, then that stimulus has meaning" (p. 35).

Meaning, then, lies in the temporal relationships between a given musical term and those that precede and follow it, and listening to music involves the perception, recognition, and above all anticipation of these meaningful relationships. For the listener is always, consciously or otherwise, projecting himself into the future, setting up expectations, modifying them on the basis of further perceptions, and seeing them fulfilled or pleasantly deceived as the music develops. In other words, all music involves temporal patterns, whose perception by the listener is the communication of musical meaning.

In dealing with this perception Meyer relies chiefly on the gestalt laws of *prägnanz*, good continuation, and closure. But he is no uncritical layman; with Hebb he rejects the gestalt "explanations" of perception, and condemns the neglect of learning. The expectations aroused by a musical statement are only in general referable to our natural urge towards clarification and closure; their specific character is always dependent on knowledge of the musical style concerned, and hence on learning. Thus music is not a "universal language"; there are as many languages as styles, and

each is a syntactical system having its own logic on which the listener may base his expectations. These have the nature of probability assessments, which shift from moment to moment and are never completely fulfilled. Where no expectation can be formed the music is meaningless, but exact fulfilment would be intolerable dullness.

This bald outline of Meyer's thesis does him scant justice, for his most convincing achievement is its articulation and application to scores of musical examples from every area and period. These sections show the infinite flexibility of the general formula, and the numberless means which composers have used to heighten affect, postpone resolution, create ambiguity, and produce new tensions and expectations. Much that has seemed mysterious about artistic creation here becomes intelligible, and Meyer's book is undoubtedly the best thing in its field.

How many psychologists are likely to read it? Relatively fewer, one fears, than in earlier and less specialized periods of our discipline. Some, of course, will be unable to read the musical examples, but others will simply feel no interest in the subject. This is a pity, for we must not become the barbarians of the Arts faculties, and Meyer has much to tell us, not only about music but about psychology. In particular, he suggests the limitations of our present conceptions of learning. We focus largely on the dull, mechanical determination of present behaviour by past experience. Meyer, giving the same weight to learning, shows us instead how it enables man to project himself into the future—an area which is not determined, but pregnant with expectations, uncertainties, and absorbing possibilities. It is a far more human picture.

J. D. KETCHUM

University of Toronto